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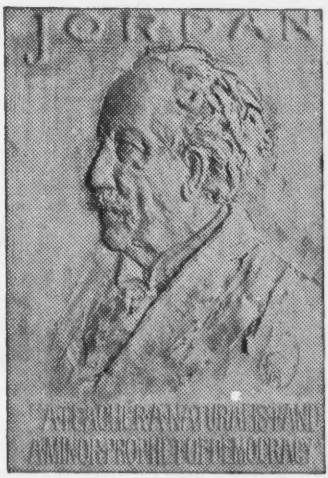
A JOURNAL OF COLD-BLOODED VERTEBRATES

ESTABLISHED IN 1913



THE DAVID STARR JORDAN ANNIVERSARY NUMBER

PUBLISHED BY

THE AMERICAN SOCIETY OF ICHTHYOLOGISTS AND HERPETOLOGISTS

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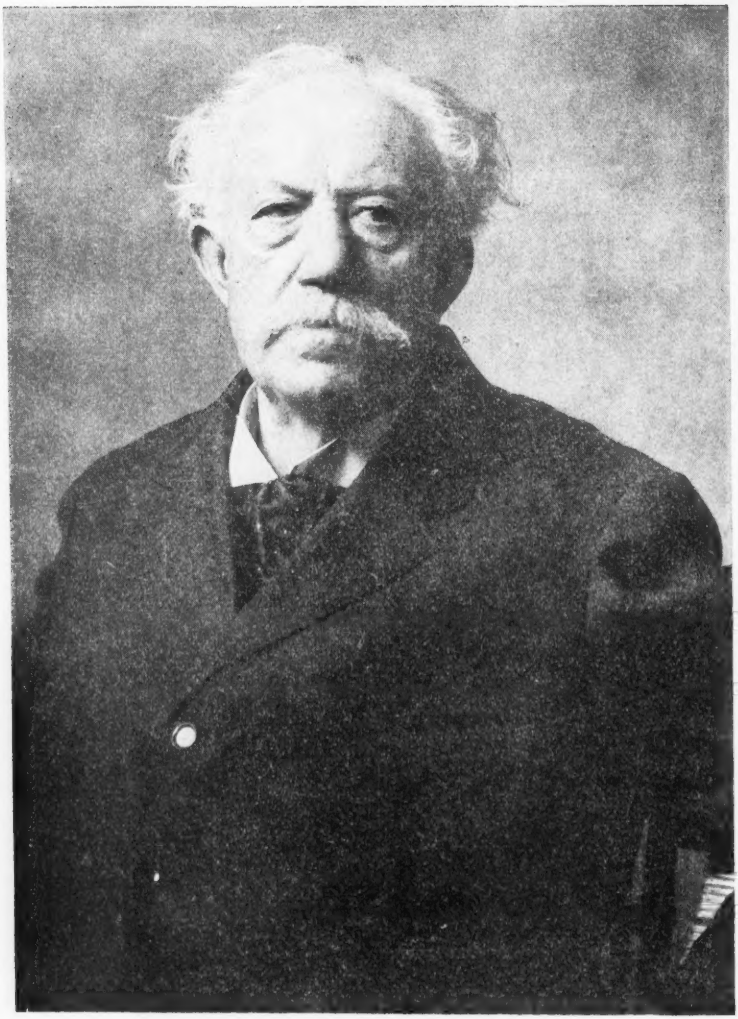


David Starr Jordan, dean of American ichthyoligists, to whom this number of Copeia is dedicated.

David Starr Jordan, the Man

By Barton Warren Evermann

I HAVE known David Starr Jordan intimately for more than 50 years. Our first association in field work was 52 years ago. Our first joint laboratory studies began 48 years ago. Our first joint paper was published 45 years ago. Not a year has passed since 1885 that we have not worked together upon some ichthyological problem; I, of course, always as his proud and happy assistant. We have carried on field work together in most of the states of the Union; also in Nova Scotia, New Brunswick, Canada, British Columbia, Alaska, Yukon Territory, Manitoba and the Hawaiian Islands. We each, sometimes alone, but often together, have caught fish in one way or another in every state and territory in the United States and in all the other countries mentioned above. With him at one end of a seine and me at the other, we have together waded more than 50 miles in creeks, rivers, ponds, lakes and in coastal waters, collecting fishes. I have been his fortunate assistant on many important expeditions and investigations; to Florida in 1886; to Virginia, Tennessee, and North Carolina in 1888; to Colorado and Utah in 1889; to Hawaii in 1901, 1924 and 1925; to Alaska and the Yukon in 1903; and along the entire United States-Canadian boundary in 1908. I have been with him under many and diverse situations, mostly pleasant, some of them rather trying.

Through these years of intimate association I came to know Dr. Jordan, the man, from many angles, and probably more intimately than any others of his scientific friends had the good fortune to know him. I shall, therefor, devote this brief article primarily and chiefly to incidents and stories of a personal character which show the human side of the man. I first met Dr. Jordan in the spring of 1877. He was then professor of natural history in Butler University at Irvington, four miles east of Indianapolis. I had arranged to spend my vacation from April to September of that year in Indianapolis with Professor Daniel Hough, then state agent for Wilson, Hinkle & Company, publishers of school books at Cincinnati. Professor Hough's office was in the book store of Bowen, Stewart & Company, on Washington Street.

My wife suggested that she would like to enter Butler as a student and remain during my period of employment in Indianapolis. We agreed that that would be an excellent thing to do; so we at once went out to Irvington to see President Benton. He was absent at the time and we were told to see Professor Jordan, the acting president, who would attend to our wants.

When we entered the room to which we were directed, we saw a tall young man sitting at a small, narrow, low table, writing. He had light

DAVID STARR JORDAN
From photograph copyrighted
by Frank Davey

colored hair, equally light, sparse beard, and wore a light colored suit. He was seated well down in the chair, his legs under the table. As we approached, he looked up and, in his efforts to get his feet and legs from under the table, almost upset it!

When we told him what we wanted, he filled out a matriculation card which he handed to Mrs. Evermann. When told that she particularly desired work in botany and English literature, he seemed pleased, and said that botany was one of the subjects he was teaching, and that she could enter his class at once.

As to where we should live in Irvington, he suggested that his friends, Dr. and Mrs. A. W. Brayton, were rooming at a Mrs. Beadle's and that he thought Mrs. Beadle had an extra room that might be had. He remarked that the Braytons were enthusiastic botanists and that he and Mrs. Jordan and Charley Gilbert lived next door to the Beadles and that they all, including the Braytons, took their meals there. As all were studying botany and birds at the time, he suggested that Mrs. Evermann might find it helpful and pleasant to join the group. She did so. As all of them were doing a great deal of collecting of plants and birds that spring, identifying and pressing the plants for herbarium specimens, and identifying and skinning the birds collected, the associations proved very helpful, and Mrs. Evermann became interested in birds as well as in botany. She learned to make excellent study skins of birds, and in botany was awarded a prize for excellence in that subject. The prize was a copy of Dr. Jordan's Manual of Vertebrates, which had only recently been published. Receiving a copy of that useful handbook from Dr. Jordan, Mrs. Evermann always regarded as a great honor.

When we returned in the fall to resume our work as teachers in the public schools of Camden, Mrs. Evermann had become so enthusiastic in the study of botany and birds that it was very easy for me to catch her enthusiasm. We devoted our spare time that winter and the following spring to collecting and studying the birds and plants of that vicinity, and soon had a good collection of the species to be found there.

In the summer of 1878, Dr. Jordan, with Dr. Brayton and Charley Gilbert, conducted a party of students on a long walking or hiking trip through the South. Mrs. Evermann and I joined the party at Indianapolis

June 20, whence we went by train via Cincinnati to High Bridge on the Kentucky River, and then on to Sumerset, Ky., where the walking began June 22. There were 15 in the party. It was really a traveling school, the principal subjects studied being the botany, geology and zoology of the region through which we passed. Of course, the wonderful scenery interested all, and many of the party paid much attention to the people and the local history of the country. Jordan, Brayton and Gilbert had previously been through much of the same country.

Before starting out in the morning, Dr. Jordan would find out the names of all the people living on the road for 20 miles or more ahead. We would decide where we would stop for noon luncheon, and where we would stop for the night. We would then "hit the trail," singly or in small groups, making no special effort to keep together, but with the understanding that the first one reaching the nooning place would order luncheon for 15; and the first one reaching the place where we had decided to spend the night would order supper, lodging and breakfast for 15. The natives usually mildly protested that they were not fixed to keep travelers, but after a little explaining and assurance that our needs were very simple, they said they would do the best they could.

Among our most delightful days were those spent from Tennessee up the French Broad River to Asheville, North Carolina, and on up the beautiful Swannanoa through Christian Reid's "Land of the Sky" and the "Great Smokies" to the top of Mount Mitchell, 6707 feet high, the highest mountain east of the Mississippi and the most beautiful. The scenery was most wonderful; the Swannanoa was a charming stream with several interesting darters and other species of fishes in its waters, and its banks with a wonderful profusion of azaleas, laurels, rhododendrons and other beautiful shrubs.

One Saturday afternoon we came upon a little country school house in which church services were being held. Dr. Jordan was always interested in the people whom we met and at his suggestion we all went in and attended the services. A young man, evidently a native who had been away at a church school somewhere, was just beginning the services. The coming in of 15 strangers, unannounced, created some embarrassment, but Dr. Jordan promptly explained to him and the small congregation of about a dozen women and children and a couple of men, whom we were, that we were interested in his work and would be glad to remain during the services. He seemed reassured, and went on with his program. He announced a hymn which most of us knew, and when we all joined in the singing, the entire congregation became imbued with the spirit of the occasion and sang, I dare say, with greater enthusiasm and zeal than was their wont.

The young man got through his sermon fairly well. After the final hymn was sung and the audience was about to be dismissed, Dr. Jordan said: "Brother Miller, wait a minute, you have forgotten one thing; you should take up a collection. With your permission, I'll pass the hat." Which he did. I think every one of our party contributed. When Dr.

Jordan handed the amount to the minister he received it very gratefully and spoke a few words in appreciation. After the benediction we tarried for a time to meet the minister and the members of his little flock which, I am sure, was spiritually good for all of us.

We stopped for the night at Glasses at the foot of Mount Mitchell. There were two or three young men in the Glass family. They told us rattlesnakes were common on the mountain and suggested we ought to have a little antidote for use in case of accident. No, he did not have any that he could let us have, but he knew where some applejack could be had. When one of our boys said he would go for some if one of the Glass boys would tell him the way, they replied: "We think you better not go; we'll go get it for you." The moonshiners and their neighbors in the North Carolina mountains are a cautious folk. The next morning a bottle of "snake-bite" antidote was given us, but we saw not a rattlesnake in the three days we were on the mountain. We spent the first night on Potato-top, where there had been a summer hotel before the war. We made a camp fire of old boards, remnants of the hotel, around which we sat, telling stories and singing songs until so late that Dr. Jordan who was tired and wanted to sleep, became annoyed and intimated that some of the boys had been tasting the applejack so often that they couldn't behave. This brought forth a disclaimer in not very courteous words from Charley Van Der Voort. Apologies all around next morning, and everybody happy as we continued on to the top of Mount Mitchell, where we spent the night. After sunrise the next morning we started down the mountain for Asheville, 32 miles away, which we reached before supper time. We stopped at the Eagle Hotel, then the leading hotel in Asheville, and a popular summer resort for people from the southern lowlands. After the members of our party had cleaned up, one of them was at the piano in the large ball room, two or three pairs were waltzing, others were enjoying themselves playing croquet or in a large swing on the lawn, while a number of southern grand dames looked on in astonishment. "You tell me you all walked all the way today from the top of Mount Mitchell? Your women, too? Why, suh, it's 32 miles to the top from heah! Well, I can understand how it happened you all whipped us all in the wah. When you all, includin' your wimmen, can walk 32 miles in one day, and then carry on the way you all are carryin' on now, it's no wonder you all beat us all."

From Asheville we went southwestward through North Carolina, and just a week later the entire party spent a night on the top of Whiteside Mountain. Getting up early we walked four miles to the foot of the mountain where we had breakfast, then on toward Clayton, Georgia, 26 miles to the first house. Charley Van Der Voort was the first to arrive. He found the man of the house somewhat drunk and stubborn. He flatly refused to entertain us. Van Der Voort explained that there were three women in the party, that when they reached his place they would have walked 30 miles that day, that it was 10 miles to the next house, and that it would be impossible to go further. But he still refused. In the meantime we had interviewed the women folk at the house and learned that they

were quite willing we should stay, whereupon, Van Der Voort said: "Now, my friend, we all are tired out; our women are very tired and do not feel they can go another mile; your wife and daughters are quite willing we should stay. There are 15 of us and only one of you. We are going to stay." To which he replied: "Well, now, suh, since you put it *that* way, I shall be delighted to have you all stay." In the morning when Dr. Jordan paid the fellow's wife $8.25 (15 cents for supper, 25 cents for lodging and 15 cents for breakfast for each of the party) the man was quite pleased. That was probably more ready cash than the family often had at one time.

Usually each noon, while waiting for luncheon, and often in the evening after supper, Dr. Jordan would give a lecture or informal talk on some subject connected with the geology or natural history of the country through which we were traveling. These talks were, I think, the most interesting, the most inspiring, I ever heard, and we all listened to them with rapt attention. I do not think I ever listened to a course of indoor lectures that gripped me or had such influence on my life as those informal talks had.

Our walking trip ended at Toccoa Falls, Georgia. We had been on the road just a month and had walked over 550 miles.

At Toccoa Falls the party disbanded, all returning home except Dr. Jordan, Dr. Brayton, Miss Clapp, Mr. Gilbert, Mrs. Evermann and myself, who went to Beaufort, N. C., where we spent a month collecting fishes, birds and other natural history specimens, and the local flora. Then we went by boat to Washington, D. C., where we spent two weeks at the National Museum and sightseeing.

Our month at Beaufort was most delightful in every way. Dr. Jordan was intensely interested not only in the fishes but in all other forms of marine life and also in the botany of the coastal plain. Neither Mrs. Evermann nor I had ever seen the ocean, nor any of the many interesting plants such as Venus' fly trap, pitcher plant, etc., which abounded in the swamp back of Moorehead City. Everything was so new and so strange to us. And Dr. Jordan was so thoughtful in telling us where to go for different things of special interest. Dr. Jordan's chief interest was, of course, in the fishes but, wonderful naturalist that he is, his interest and knowledge extended to all groups of animals and plants, including even the people, whites and blacks. We rented as a laboratory a large room in a building that stood over the water. Very soon young negro boys began to bring us specimens of one sort or another. Dr. Jordan began to make a study of these boys.

In a note-book, he wrote each boy's name, his age, color (whether black, dark, yellow or tan), kind of hair (whether simply black and wooly, kinky, or pepper-corn), and what his specialty was—whether singing, dancing, patting jubah, or what. Then he would have them give us an entertainment by competing in their respective specialties.

We at first acted as judges and gave a small prize to the one we had decided was the best. Later, we charged the boys a penny each for the privilege of entering the contest, and let the boys themselves be the judges

as to who should have the pot, to which we added an equal amount. When we gave the money to the winner they all left together, and in a few minutes we would see them all behind a house nearby eating a watermelon they had bought with the pot!

I have always felt that these three months of daily and intimate association with Dr. Jordan constituted the most decisive single event in my life. Seeing him under so many situations, listening to his lectures on a wide range of subjects, and hearing his dry wit and humor, my admiration for him became unbounded. Before the trip was over Mrs. Evermann and I had decided that we would enter Butler in the fall of 1879 and get as much as possible of Dr. Jordan's work. But in the summer of that year, Dr. Jordan resigned his position at Butler when the Trustees passed a resolution stating it to be their policy to fill all the professorships with members of the Christian Church so far as practicable. Dr. Jordan, not being a member of that church, promptly resigned and went to the State University at Bloomington to take the professorship of Natural Sciences from which Dr. Richard Owen had just retired. Dr. Jordan had taken his friend Brayton down to Bloomington to recommend him for the place; but the Trustees asked Dr. Jordan if he would take it!

As we had all our arrangements made to go to Butler, that, of course, upset our plans, and, when I received an offer of the principalship of the schools at Santa Paula, Calif., I accepted it; and we went to California.

I wrote Dr. Jordan that an opportunity to go to California had come to me and that, as such opportunities do not come every day, we had accepted it and were now in California. A few days later I received a letter from him saying: "An opportunity to go to California does not come to one every day, but one has come to me and Gilbert, and we'll be out there early in January." He had been appointed to take the fishery census of the Pacific Coast, and they came out to do it. When they came to San Buena Ventura, I spent some days with them. I recall that we spent one Sunday opening an Indian mound at Cañada de Largo near Ventura. This was done at the request of Professor Baird.

Dr. Jordan asked me to join him in the fishery census during my summer vacation, and got a pass for me on the steamers of the Pacific Coast Steamship Co., from Hon. Geo. C. Perkins, later a U. S. Senator for California.

This census of the Pacific Coast fisheries was unique. It covered not only the commercial fisheries; it was also an ichthyological survey of the coast from San Diego to Puget Sound, and resulted in the discovery and describing of more new species than any fishery survey previously made; a fact attested by the numerous contributions to ichthyological literature by Jordan and Gilbert in the Proceedings of the U. S. National Museum in the early 80's. It was this work that led Jordan and Gilbert to write their Synopsis of the Fishes of North America, published in 1882 as Bulletin 16, U. S. National Museum, which gave the first great impetus to the study of North American fishes.

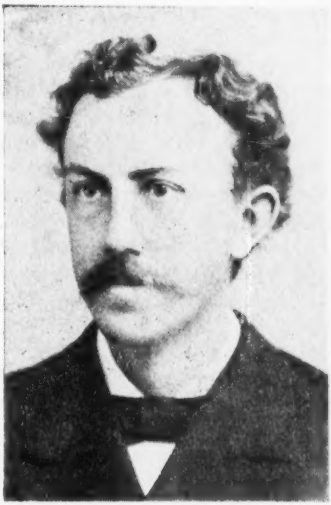
Dr. Jordan returned to Indiana University in 1880 upon the comple-

tion of his census work on the Pacific Coast, and Mrs. Evermann and I returned to Indiana and entered the University at Bloomington the next fall (1881), to get all the work we could as students of Dr. Jordan's. He and Dr. Gilbert had just returned from a summer in Europe, made famous by their ascent of the Matterhorn, the thrilling experiences of which Dr. Jordan has so often told in his charming lecture: "The Ascent of the Matterhorn," which he has given probably oftener than any other one of his long list of public lectures.

Dr. Jordan, early in his professorship at Indiana University, came to be recognized as the most outstanding member of the faculty. He was a wonderful teacher, his subjects were elective, and he drew about him a big percentage of the best students in the university; and a large percentage of those who entered his classes graduated from his department. The graduating classes in those days were small; for example, that of 1886 had only 20 members, but six of them majored with Dr. Jordan, and four of the six became professional zoologists.

In the summer of 1883, the Science building in which Dr. Jordan had his rooms and collections at Indiana University, burned. The collections and several important manuscripts which he had practically completed were all destroyed. This disaster had much to do in causing him thereafter to publish promptly on the completion of a manuscript.

On January 1, 1885, Dr. Jordan became president of Indiana University, very much to his surprise and regret. His ambition did not lie in that direction. He accepted the appointment with great reluctance, but he saw that it opened to him great opportunities in the fields of science and education. He insisted that the biological and physical sciences and modern languages possess educational values and training not inferior to that claimed for mathematics and the dead languages. He made the curriculum more elastic by enabling the student to "elect" to a limited extent under advice of his major professor. He provided a "major subject" system, by which juniors were required to choose a specialty, or major subject, and to work under the immediate supervision of his "major professor,"—something quite revolutionary and quite unheard of in many colleges in America at that time, but destined soon to be adopted by most of them.



DAVID STARR JORDAN, 1884
President of Indiana University

It would be difficult for any one not personally cognizant of the forces acting at that time to realize the boldness of President Jordan's fight for a well-considered adaptation of the curriculum to the needs of the individual which could be best attained through a rational elective system by which each student chooses his own line of work and is stimulated to pursue it to a degree of mastery. Dr. Jordan's contention was not that Greek and Latin should be abandoned or neglected, but that ample provision should be made for the sciences and the "humanities."

When the Indiana Academy of Science was organized in 1886, and Dr. Jordan was made its first president, he chose as the subject of his presidential address "The Dispersion of Freshwater Fishes," in which he set forth in a most fascinating story all that was then known of the various ways in which fishes extend from one drainage basin to another.

In the spring of that same year he invited me to go with him to Pensacola, Florida, to collect fishes. Among other members of the party were Charles Harvey Bollman, a very promising young naturalist who, three years later, died of fever while collecting fishes in the swamps of southern Georgia, and Charles Lincoln Edwards, now the enthusiastic and efficient director of nature study in the Los Angeles public schools. On this trip Bollman and I each made a cruise on a fishing smack to the Red Snapper Banks off Cape San Blas, which resulted in the discovery of a number of new species and one new family of fishes (Steinegeridæ) among the stomach contents of the red snappers and groupers which we caught with hook and line at depths of 40 to 60 fathoms.

It was Dr. Jordan's practice to put his students at work on special problems very early in their studies. Whether the problems were of great importance did not so much matter. Their study gave the students an understanding of, and drill in, the methods of science, which was important. By this method of teaching, the student's interest in nature was not killed off, but increased. The examination and comparison of many specimens of related species and of the same species gave him an understanding of what a species is, and how different species are brought about. Dr. Jordan's great power as a teacher was largely due to this method of instruction.

Usually, the problem he assigned, or which the student took up, was one in which Dr. Jordan himself was interested, so that professor and student worked upon it together, the student up to his ability, the professor passing upon the more difficult technical questions and putting on the finishing touches. If the results of the study seemed worth publishing, the paper usually appeared under the joint authorship of professor and student, the professor always having done the larger, more difficult part of the work. Dr. Jordan was always ready to give his students more than full credit for the work they did. He has had associated with him a greater number of assistants as junior author than any other author that I recall. As illustrating his readiness to share the authorship of his scientific contributions with others, I may mention the "Fishes of North and Middle America." In the winter of 1893-4, I was "loaned" by the U. S. Fish Commission to help Dr. Jordan with that monumental work, and I went out to

Stanford University for that purpose. When the first galley proof came from the Government printing office, and we had read it through, Dr. Jordan picked up the title page and wrote in my name as junior author, with the remark: "There are too many things in this that are not so, for one man alone to shoulder all the responsibility."

In the spring of 1894, I returned to Washington where I continued to do such work on the book as I could do there. Dr. Jordan would send on to me from time to time batches of manuscript he had completed. I would do such editorial or other work as had been assigned to me and then send them on to the printer.

On the Fur Seal Investigations of 1896-97, Dr. Jordan took the opportunity to make considerable collections of fishes and, as many new species were discovered, he thought it would be a pious idea to name a new species for each of his associates on the Commission, among whom was Prof. D'Arcy Wentworth Thompson, of the University of Dundee, the Commissioner for Great Britain. He selected a new species belonging to the genus *Podothecus* to name for Professor Thompson and sent on the description, which I promptly sent along with other manuscripts, to the Government Printing Office.

Before the galley proof had time to reach Doctor Jordan, he wrote me: "If it is not too late, change *Podothecus thompsoni* to *Podothecus jonesi, smithi,* or *any* old *Podothecus;* D'Arcy Thompson's diplomacy makes me tired." But it was too late to change it, so there is a *Podothecus thompsoni,* a little fish the type of which came from Iturup Island of the Kuril group.

Dr. Jordan's attitude toward his students was democratic, albeit with a certain reserve or dignity which prevented the student from too great familiarity; I never knew a student who felt he dared slap him on the back or call him by his first name. In the summer of 1885, soon after he became president of Indiana University, he and several of his special students were working in his laboratory in old Owen Hall. On Saturday afternoons the students usually went out to Griffy Creek, a mile or more north of Bloomington, for a swim. One Saturday, as the boys were leaving the laboratory to go to their luncheon, Dr. Jordan asked if they were going for a swim that afternoon, where they would start from, and when. When the boys gathered at the place of rendevous Dr. Jordan was there and asked permission to go along. Of course they told him they would feel highly honored to have the President joint them; but when some one expressed surprise, Dr. Jordan dryly remarked: "When Dr. Moss was made president of the university he made one request of the Board, which was that he be permitted to attend any Baptist assembly or meeting he wanted to attend, without having to ask special permission. When I was elected president I also made one request: that I should be permitted to go swimming with the boys whenever I felt like it!"

One fall he and his secretary, Geo. A. Clark, spent some time in Washington at the State Department in connection with international fur-seal problems. The forenoons were usually spent at the State Department and the afternoons at the Fish Commission. One afternoon Dr. Jordan came

in and announced he would leave for California the next day. "No," he said, "we are not through with the fur-seal matters, but the State Department needs a rest; and of much greater importance, I must leave tomorrow in order to reach home in time for the California-Stanford Big Game on Thanksgiving." A few days later, a brief letter came from him with this written in red ink across the top: "Stanford 6, California 0! And the red flag waves."

And this illustrates another of Dr. Jordan's many interests. He was always keenly interested in athletics, and took an active part in the games between the students and the faculty.

In the summer of 1889, Dr. Jordan, assisted by Bert Fesler (now a distinguished judge at Duluth), Bradley M. Davis (now professor of botany in the University of Michigan), and myself, explored the streams and lakes of Colorado and Utah for the United States Fish Commission. One of Dr. Jordan's great scientific interests was the geographic distribution of freshwater fishes. This season's work afforded him many opportunities to study the factors that have to do with this problem. We had many interesting experiences. At one place a game warden arrested us for seining. When told that we were operating under the authority of the United States Government, he asked to see our permit. He was told the permit had been left in our rooms at the hotel which was some little distance away. He said: "I do not know whether it is or not. Come along with me to the hotel and produce it." We all went with him, got the permit and showed it to the warden who examined it and remarked: "Well, that seems all right. The fellows around here have been telling me I'm no good as a game warden; never able to see any law violators, and afraid to arrest anybody when I do see one. So when I saw you fellows using a seine, I made up my mind to arrest the whole outfit and make an example of you all. I guess I made a mistake. The boys will josh me more than ever. You may go." Dr. Jordan told him he did exactly right in insisting on seeing our permit, and commended him as a courageous and energetic official.

At another time we went down into the Land of Joab to examine Sevier River. When we reached the river Dr. Jordan said: "I forgot to bring along my seining suit; left it at the hotel. So you boys will have to do the seining while I stay on the bank and examine the catch as you bring it ashore." We had wonderful success, getting great numbers of fishes, including several species of special interest. Dr. Jordan became quite excited and disappeared in the bushes, coming out in a minute wearing only a long linen duster, and remarking excitedly as he took hold of one end of the seine and waded in: "This is great fun! I must have a part in it."

On another occasion we went to the Rio de las Animas Perdidas, the River of the Lost Souls. We struck the river a few rods below a bridge and Dr. Jordan said: "It is too deep here to seine; let us cross over and seine on that shore over there which looks like a good place; we can get through this deep water here by stepping on these big rocks." Fesler suggested that we go up to the bridge and cross on it, but Dr. Jordan said: "No, we can cross on these rocks," And suiting the action to the word,

took up one end of the seine and started across. Fesler took the other end, Davis the middle, I the collecting bucket, all reluctantly following Dr. Jordan who was stepping cautiously from stone to stone. But he had gone only a short distance when he made a misstep and slipped off up to his neck in the ice-cold water! He gathered up the end of the seine and got back to the shore as best he could, we all following in silence but with suppressed emotions. Upon reaching the shore, Dr. Jordan, between shivers, casually remarked: "I have always understood that the place where lost souls go is a good deal warmer than that." Then we all went up and silently crossed on the bridge.

When we came to pay our livery bill at Cañon City, Colorado, we had to explain to the hostler before he would give us a receipted bill that we were examining the streams and lakes of the state for the United States Fish Commission. "Then you all live in Washington, D. C., do you?" When we told him no, he asked: "Then where do you live?" When we told him that Dr. Jordan lived in Bloomington, Ind., Bert Fesler in Indianapolis, Bradley Davis in Chicago, and I in Terre Haute, he thought it very strange; all engaged in Government work but none living in Washington City. After a few moments cogitating over the matter, he remarked: "Well, Washington is the seat of the disease, ain't it?" We all agreed that the hostler's conception of a government activity was not so bad.

In 1908, Doctor Jordan was the Commissioner and I Associate Commissioner representing the United States on an International Commission appointed to make a study of the fisheries along the boundary between the United States and Canada. Early in July we began at Eastport, Me., and made a study of the many complex fishery problems in the waters along our northern boundary from there to Vancouver Island. When we had finished the work about Niagara Falls (July 25), Dr. Jordan said to us: "If you will go with me out to Warsaw this evening, I'll get an automobile tomorrow morning and show you the sort of country that produces college presidents, ichthyologists and international fish commissioners. I'll take you out to the old farm where I was born and where my first ichthyological investigations were made." Herbert Stolz (his secretary) and I accepted the invitation. The next morning we motored out to the old farm where Dr. Jordan was born and where his boyhood days were spent. It was a hot Sunday morning. The owner of the farm and his wife were sitting under a shady tree in the yard. Dr. Jordan told them who he was and asked if he might go through the house. He invited me to go in with him. As he went from room to room he told me whose each was,—this was his father's and mother's, this his sister's, and this was his. It was interesting and fine to hear his comments and to see the changing expression on his face as we passed from room to room.

Upon returning to the yard, Dr. Jordan called attention to a row of apple trees that extended along a fence back from the house, and said: "I planted those trees myself. They are fine trees." "Yes," said the old lady, "That is just where you made the mistake. Anybody who knows anything about party-lines and neighbors would never have planted the trees so close

David Starr Jordan, with Orlin Cotton (at right), his first teacher, who advised him to go to Cornell, and Barton Warren Evermann, Gainesville, N. Y., July 26, 1908

to the fence. We have to give half the fruit to the neighbors in order to avoid a fuss."

Then we walked to the back part of the farm to see a small pond or cranberry marsh. When he was a boy it was quite a pond, but it seemed to be growing over with cranberry and other vines. Whether it had become entirely grown over could not be seen from the shore, but Dr. Jordan was curious to find out. So he said: "The only way is to wade out on the matted vines which I think will bear us up." Divesting ourselves of all clothing except hat and undershirt, we waded out. The matted covering of vines was firm enough to support us and we found the pond entirely grown over. Herbert Stolz remained on shore busily engaged with his kodak.

As we drove from the farm down to Gainesville, a mile distant, Dr. Jordan told us of Niram Barrell, a boy chum of his now living in Gainesville. "When I went to Cornell, I wanted Niram to go with me, but he didn't go. Let us hunt him up and find out who made the mistake."

We found Mr. Barrell swinging in a hammock in his backyard. After the usual greetings, Dr. Jordan told Niram that we were going to spend the day driving about over the country and invited him to get in and go with us, which he did. Mr. Barrell proved to be a quiet man, not talking much, but when he did say anything it was well worth hearing. After spending the day together very pleasantly we returned to Gainesville. As we let Mr. Barrell out at his house Dr. Jordan said: "Niram, you ought to come out to California. When men from Wyoming County come out to California we make some of them college professors, some college presidents, some we elect Governors or United States Senators; you come out and we'll send you to Congress." To which Niram replied: "Well, David, I can see that would be very nice. But I remember reading in some old book—I forget now just the name of the book, about somebody—I can't remember his name just this moment; I am getting *so* forgetful—about somebody who took somebody else up to the top of a high hill and showed him a whole lot of things which he said he might have; but, if I remember the story correctly, *he couldn't deliver the goods.*"

As we drove away, Dr. Jordan dryly remarked: "Niram always was a pessimistic as well as a sarcastic cuss."

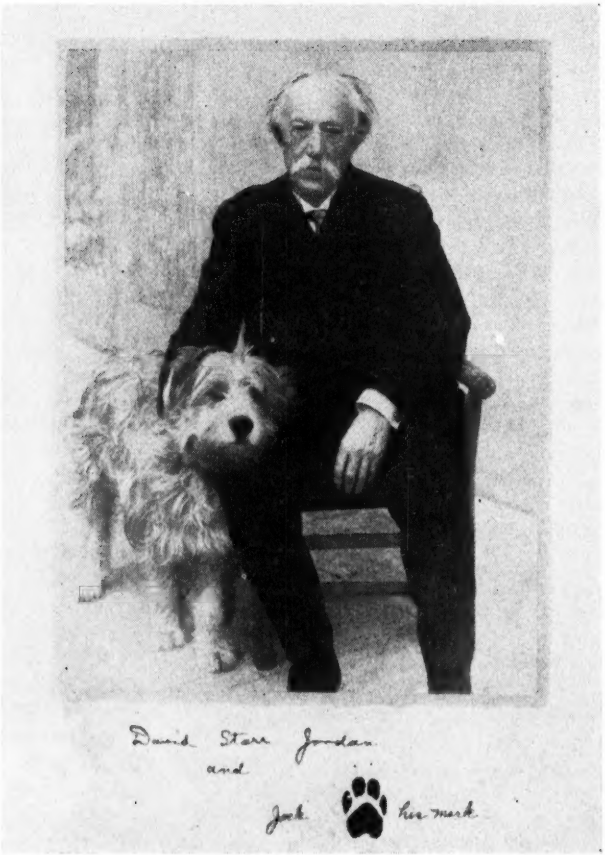
It has not been my purpose in this article to write of the great accom-

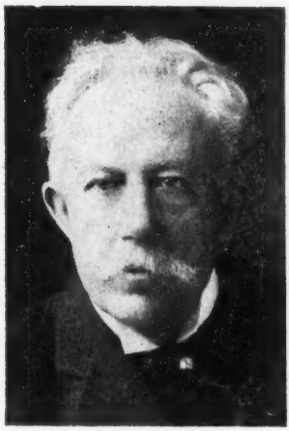
plishments in each of many fields in which David Starr Jordan has rendered signal service to the world; all that may be left to others and for other occasions. The object at this time has been merely to tell a few stories, incidents, and events in his wonderfully active life which will help us to understand what a broad, sympathetic, big-hearted human being he is, and that we may realize those human qualities that endeared him so strongly to his students and co-workers, all of whom will ever hold him in highest esteem and love.

I can do no better than to close this article with the felicitous words written by President Herbert Hoover as the Dedication to David Starr Jordan of "The Stanford Quad" for the collegiate year 1929-30:

"First president of our beloved university, creator of its oldest traditions, scientist of unquenchable thirst for truth and of unalterable integrity in its search, teacher of sympathy and imagination, friend of youth, wise counselor, believer in the inviolable sanctity and worth of the individual human soul, exemplar of the moral virtues, inspirer to the spiritual life, apostle and prophet of peace, this book is dedicated with veneration, devotion, and affection."

Museum, California Academy of Sciences, San Francisco, California.


David Starr Jordan
and
Jack his mark



To David Starr Jordan

"GO wherever the Masters are in whatever field you wish to study". This was the advice you gave us at the little Quaker Academy in Indiana more than thirty years ago.

Because you were the Master in zoology we came to you.

Now therefore we affirm that your advice was sound. As our small tribute we wish to bear witness to the clearness of your teaching, the depth of your knowledge, and the goodness of your heart.

ALVIN SEALE, Steinhart Aquarium,
San Francisco, California

David Starr Jordan and Ichthyology in the Pacific

By Henry W. Fowler

NO other naturalist has ever had so great an influence on the progress of the study of the fishes of the Pacific Ocean as David Starr Jordan. In looking back over his work we see him early established as a leading authority on fishes before he moved to the Pacific coast. His pivotal contribution, *The Manual of Vertebrates of the Northern United States,* had already been well established and had then passed through several editions, thus well on the way to the present, thirteenth edition. From this abbreviated work has developed much of the general interest in natural history in America today, so one could hardly pass without appropriate reference to it.

Though the development of ichthyology in North America followed the trend across the continent to the Pacific, it was not until David Starr Jordan established himself in California that a definite start was made. This began with very extensive studies of numerous collections, obtained chiefly on the shores of the Pacific States and Mexico, resulting in scattered papers from 1878 to the early eighties. In 1886 he prepared a list of the fishes then known from the Pacific coast of tropical America from the Tropic of Cancer to Panama, followed by the Mazatlan paper of 1889 and that on Sinaloa in 1895. With one of his most distinguished students, the late Charles Henry Gilbert, he carried on his most extensive labors, resulting in innumerable papers referring to California in 1880, Mazatlan in 1881, Panama Bay in 1882, west coast of Mexico and Lower California in 1882, the latter also, in 1883, Puget Sound and Vancouver. A list of Pacific Coast fishes for the United States was published in 1890, and one for Bering Sea in 1899. With Richard C. McGregor the fishes of the Revillagigedo Archipelago and neighboring islands were reported on in 1899. Pierre Louis Jouy assisted with the study of Pacific coast fishes in 1882. Edwin C. Starks contributed to the reports on the fishes of Puget Sound in 1895, of Mazatlan in 1896, and of California in 1907. With Charles Harvey Bollman the Galapagos fishes were reported on in 1890.

The interesting discovery of the Japanese goblin shark (*Mitsukurina owstoni*) heralded the work in Japan in 1898. There followed for many years numerous papers—many extended reviews and monographs. Many published jointly with John Otterbein Snyder, appeared from 1900 to 1906; with Starks, from 1901 to 1906, and with Michitaro Sindo in 1902. The writer also collaborated in the work on the selachians, cyprinids, silurids, chaetodontids, Sclerodermi, callionymids, brotulids, and others, in 1902 and 1903. Other reviews and lists were published with Alvin Seale in 1906; with A. C. Herre, on the herrings, cirrhitids, synodontids, in 1906 and 1907; with Robert Earle Richardson in 1907, 1908 and 1910; with William F. Thompson in 1911 and 1914, and with Carl L. Hubbs in 1925.

Contemporaneously, work was carried on with Barton Warren Evermann on Formosan fishes in 1902, on Chinese fishes with Starks in 1903 and 1906, and with Seale in 1905 and 1907; also with Snyder in 1906. Still other papers are those with Starks in 1905 on Korea and in 1907 on Riu Kiu.

The Hawaiian exploration definitely began in conjunction with Evermann in 1904 and 1905, also with Snyder in 1904, 1905 and 1907. Work was started on the Philippines with Seale in 1905 and 1907 and with Richardson in 1908 and 1910, who shared in the preparation of a valued checklist for these islands. Other noteworthy works were those with Seale in 1906 on the Samoan collections of the United States Bureau of Fisheries, the report on which was extended to include all the species then known in Oceania. Seale also appears as co-author of the report on a collection from Java in 1907. Besides these are reports with Snyder on Tahiti fishes in 1905, and with Mary Cynthia Dickerson on Fiji fishes in 1908.

In more recent years the founding of the Pan-Pacific Research Institute at Honolulu has shown Dr. Jordan always a leading figure with unflagging interest. Its journal has usually some item of interest in each number for the student of fishes. An effort to solicit the cooperation of various investigators of ichthyology in all the lands bordering the Pacific has resulted in many lists of the fishes from the various Pacific seas.

The present sketch, brief as it must be, scarcely does full justice to the great power of our teacher, though possibly indicating at least a few of his more prominent achievements in Pacific ichthyology. Just as the *Synopsis of the Fishes of North America,* published in 1883 with Gilbert, and *The Fishes of North and Middle America,* in 1896 to 1900 with Evermann, are epoch-making works in American ichthyology, likewise are the *Shore Fishes* in *The Aquatic Resources of the Hawaiian Islands* (1905) with Evermann, and *The Fishes of Samoa* (1906) with Seale, outstanding monuments in Pacific ichthyology. They are truly important faunal works and of the first magnitude, ranking as modern expositions in comparison with the early voyages, the last of which really culminates as the great *"Fische der Südsee"* by Günther, based on Andrew Garrett's collections.

Who can appraise the work or efforts of our many colleagues, many of whom had their inspiration, often their training or their ideals, moulded under the masterly influence of David Starr Jordan? Sometimes this was due to only slight personal contact, or perhaps only through correspondence. So varied and wide reaching were his many activities, either as educator, teacher or investigator, that it is far from my purpose to attempt to discuss them. I feel sure we may all claim the fine friendly comradeship of the man, and his sympathetic interest in the study of fishes, ever combined with all those splendid qualities of the truly great mentor. May we all extend our sincere congratulations as well as our earnest wishes for his continued well being.

Academy of Natural Sciences, Philadelphia, Pennsylvania.

Ptychidio jordani, an Unusual New Cyprinoid Fish from Formosa

By George Sprague Myers

CHINA is indeed a land of surprises for the ichthyologist, and the fish fauna of Formosa, being entirely Chinese in character, is thus of great interest. In going over the unreported collection made by V. Kühne for Stanford University in Central Formosa in 1908, I find a rather unusual new genus of Cyprinidæ apparently not very close to any known member of the family.

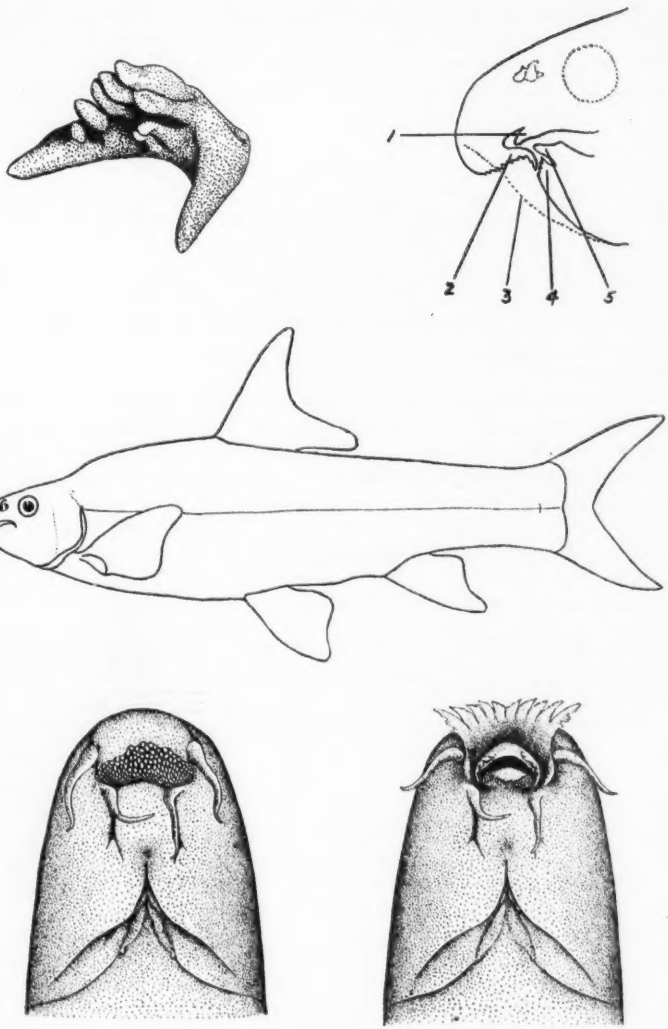
Ptychidio, new genus

Among the described genera of Cyprinidæ this form appears to approach only *Semilabeo* Peters.[1] It distinctly differs in having but two rows of pharyngeal teeth and in the absence of wide papillated lips. In the structure of the mouth it is closely approached by no known Cyprinid.

Body robust; breast and abdomen without carina. Dorsal fin inserted slightly before anal fin. Anal and dorsal each with one short spine, five branched anal rays, eight branched dorsal rays; no *deep* scaly sheath (as in Schizothoracinae) at base of either fin. No suprabranchial breathing organ. Body with moderate scales, lateral line complete, not depressed, running down middle of peduncle, the sensory tubes not divided.

Mouth inferior, with an extrusible fimbriated upper lip which is not connected with the slightly movable fimbriated lower lip. No rostral fold or groove, the smooth skin of the snout more or less abruptly becoming tuberculate as it passes into the lip. Border of upper lip formed of ten compound fimbriae, the outer longest, the minor tubercles of each fimbria confined to its exterior surface. When folded the upper lip covers the much narrower and less fimbriated lower lip, the compound fimbriæ of the upper folding inward. Four barbels, the rostral pair at the sides of and just anterior to the upper lip; when mouth is closed each is encircled at its base by a fold of the skin of the snout which originates at the sides of the upper lip. The maxillary barbels are situated closer to each other than are the rostral ones, at the tip of the maxillary process on each side of the base of the lower lip. The comparatively narrow lower lip and part of the isthmus just posterior are separated from the peculiarly placed maxillary portions of the mouth by two very deep folds, in the superficial grooves of which the maxillary barbels lie. The free fimbriated part of the lower lip is not wide and is little movable; its fimbriae are not compound. No postlabial groove. Within the oral vestibule the jaws are small, arched, and hard, without sharp horny edges, the upper with a few fleshy flaps at each side.

[1] Monatsb. Akad. Wiss. Berlin, 1880: 1032 (Hongkong or waters on mainland nearby).



Center—*Ptychidio jordani*, 1/3 P. L. Bravo, del.

Lower left—Lower view of head of *P. jordani*, mouth closed. 3/4. P. L. Bravo, del.

Lower right—Lower view of head of *P. jordani* with upper lip extruded. 3/4. P. L. Bravo, del.

Upper right—Diagrammatic median sagittal section of head of *P. jordani*. 1. Upper jaw. 2. Upper lip. 3. Outline of lower side of head. 4. Lower lip. 5. Lower jaw. G. S. M., del.

Upper left—Left pharyngeal teeth of *P. jordani*. G. S. M., del.

A deep groove marking the inferior boundary of the sub- and interopercle, which joints its fellow to form a median groove running anteriorly for a short distance on the isthmus. Opercular edge fully bounded by a wide thin opercular flap which is broadly joined to the isthmus below; no superior opercular opening closed by a velum. Cheeks and opercles heavily skin-covered, obscuring all bones. Preopercular edge faintly indicated by a depression. No sensory tubes on head. Front and sides of snout with minute scattered asperities. Eye superolateral. No gelatinous eyelid; orbital margin free. No hidden recumbent spine in front of dorsal fin.

Pharyngeal teeth in two series, 5,3-3,5, none hooked or with large flat grinding surface, the first two (counting from angle of bone) in the major series highest and rather closely appressed, the first one in the minor series heavier than the other two. All teeth more or less rounded with a slightly evident flat area.

Air bladder without vestige of bony encasement, rather reduced in size; it is divided into two sections, the anterior thin walled and rounded, the posterior elongate and pointed, with tough thick walls.

Pelvic fins horizontally inserted; pectorals rather intermediate in position, folding flat against lower curving part of sides. Caudal fin deeply forked.

Genotype the following species.

Ptychidio ***jordani***, new species

Holotype: No. 23927, Stanford University, 270 mm. standard length, from Central Formosa (probably Polisia or Kagi), collected by V. Kühne in 1908.

Description: Body somewhat compressed, oval in transverse section, greatest thickness .60 of greatest depth. Dorsum rising rather abruptly behind occiput, thence gently curved to origin of dorsal fin, which is the highest point. The dorsal base slopes downward, with a slight break at its end, thence the dorsum is straight to the caudal. The venter is evenly convex to the pelvic fins, thence runs upward, with a slight irregularity, to the anal region. The anal base slopes steeply upward, with a break at its end, and the lower edge of the peduncle is slightly concave to the caudal. Head nearly rounded in cross-section, the cheeks rather bulging, the eyes superolateral and not visible from below, the orbit somewhat vertically ovate, and the interorbital broadly convex. Orbital rim free for its entire circumference. Septa between nostril openings enlarged and flaplike.

Head length .20 of standard length. Depth .285 of same. Least depth caudal peduncle .145 of same, .720 of head length. Horizontal diameter of eye .185 of head length. Interorbital .435 of same. Distance from snout tip to dorsal origin .455 standard length. Snout tip to pelvis origin .480. Snout tip to anal origin .725.

Scales large, deeply imbricated, closely adherent, their bases squared or with slight median and marginal projections, their distal margins rounded or obtusely pointed, and their surfaces with little sculpture other

than a large number of fine diverging lines from the centrally placed nucleus to the border of the visible sector of the scale. There is a slight basal sheath at the dorsal, anal, and pelvic fins. The caudal is covered with large scales for approximately one fourth of the length of the lobes, as indicated on the figure.

Lateral line 42, plus 3 on caudal base; 6 scales between origin of dorsal and lateral line series, 5 between lateral line series and pelvic fin origin, 6 between 1. 1. and anal fin origin; 20 around caudal peduncle. Predorsal scales 14 or 15, the place of the second predorsal being taken by two very large scales, one on each side, which meet on the median line, and the place of the last being taken by two small scales on each side which form the origin of the dorsal sheath. Preventral squamation irregular with a partially developed enlarged median series. Bases of pectorals without fine scales.

Dorsal fin high, with a deeply falcate margin; the longest ray (second) is .240 of the standard length. There is a short bony ray, twice orbit diameter in length, encased in the thick integument of the second ray, which is soft, articulated and undivided. These two are followed by 8 branched rays. Each ray, including the initial short bony one, has on each side a lateral membranous extension which folds back and conceals the basal part of the succeeding ray, save on the last, where the extension is merely lateral. Anal fin with margin slightly emarginate, the longest ray (second) is .192 of the standard length. There is a short bony ray twice orbit diameter in length followed by, and encased in the integument of, the long second ray, soft, articulated, and undivided, these two being followed by 5 branched rays. There are membranous extensions similar to those on the dorsal. The pelvic fins, which are placed horizontally, have one long undivided, articulated ray, .196 of standard length, followed by 8 branched rays; membranous flaps as in dorsal and anal. The greatest length of pectoral fin is .200 of the standard length; the fin has one long, undivided, articulated ray and 15 branched ones. The caudal is strong and deeply forked, with 19 rays fairly evenly spaced, this without counting 3 visible rudimentary rays both above and below. The pelvic and pectoral fins in the figure are distorted from their normal position in order to show their form.

Gill-rakers very short and closely set, disposed in two series directed laterally, one on each side of each arch save the last, the rakers of one arch interdigitating with those of the one or two adjacent arches. The whole forms a straining device of great perfection. Fourteen rakers on each side of the lower limb of the first arch. Gill-filaments long, the longest 1.3 times the horizontal orbit diameter.

Color brownish, slightly darker above. A single specimen known.

Named for DAVID STARR JORDAN, Chancellor Emeritus of Stanford University, in slight appreciation of his friendship and many kindnesses to the writer.

NATURAL HISTORY MUSEUM, STANFORD UNIVERSITY, CALIFORNIA.

On the Structural Specilization of Flying Fishes from the Standpoint of Aerodynamics

By C. M. Breder, Jr.

A LARGE variety of flying animals has been studied by the early designers of aircraft, but it was not until there was a radical departure from any of these that a real conquest of the air was made with heavier-than-air machines. We may consider those animals that have been examined for such purposes, beginning with the lower groups. Except for the ballooning spiders, which simply drift by means of their wide flung silk on light breezes, or the flying squids that are little more than animated darts, there are no flying invertebrates except the insects. These are highly diversified and exceedingly successful. Their wings are usually of light stiff membranes stretched on supporting rods and superficially, at least, somewhat resemble the wings of a modern aeroplane. There are two important and interlocked differences, however. The first is that in all cases they are locomotor in function, and no insect attains a large (absolute) size. With such small sizes the manipulation of delicate structures is mechanically possible and indeed advantageous, if not absolutely necessary. Long continued gliding is impractical for bodies of such light weight, whereas, on the other hand, the manipulation of such thin expansive areas in a larger size is out of the question for either animals or machines, due partly at least to the fact that the weight increases by the third power of the length. Thus it is evident that such superficially aeroplane-like insects as dragon flies are really not miniature planes at all, but are working on radically different principles in which the paired outstretched wings vibrate practically all through flight in such a manner that their tips describe a figure eight in addition to rotating slightly back and forth along their long axis.

Considering the vertebrates, we may examine the birds, which for so long have been studied by would-be fliers. The flapping flight of the bird wing is conditioned by its peculiar lattice-like fenestration due to the complicated form and placement of the feathers. All the smaller birds fly by rapid wing beats, only the larger, such as buzzards, hawks, condors, albatrosses, etc., sustain long continued flight by soaring. Such flight is by far the closest approach to that of a plane (a motorless glider) that we have examined as yet, although it is still a far cry from a plane in its method of getting under way, control, or appearance in the air.

The flying mammals, such as bats and flying squirrels, although having solid wings are still further from the successful plane. The bats with their elaborate wing flapping have as yet never been successfully repro-

[1] This paper was read at the 1930 meeting of the American Society of Ichthyologists and Herpetologists, in New York. Its publication has been, unfortunately, held up for some time.—EDITOR.

duced mechanically on a large scale. The flying squirrels are more nearly in the nature of parachutes. This is also true of the flying lizards among the Reptilia, and the flying frogs among the Amphibia. Of the extinct pterodactyls little can be said except that their flight was probably bat-like.

The only flying animals remaining to consider are the flying fishes. This group of flying animals appears to be the only one that the early designers of air-craft have not considered and, as will be shown, is the one they probably could have studied to best advantage. The ability of fishes to fly has been developed in several groups, but we shall here consider only the most successful of these, the oceanic flying fishes comprising the family Exocoetidae. In the more highly specialized of these we have two distinct types. One may be compared to a monoplane, with a pair of long narrow main wings and both lateral and vertical rudders farther back (*Halocypselus*). The other may be compared to a very advanced biplane with the under wings staggered far back and seeming at the same time to have the function of elevators (*Cypselurus,* etc.). These fishes are essentially gliders and resemble a powered plane about as closely as do the increasingly more evident sail-planes. As the largest flying fish reaches only some eighteen inches in length, the question may be rightly raised as to why they do not grow larger, if they are structurally so similar to aeroplanes. This is referable not so much to the function of flight itself, but to the difficulty of a much larger craft getting out of the water, by means available to fishes, especially when encumbered by appendages adapted to flight and not to swimming. Similar difficulties are encountered even by a buzzard in getting off the ground, while condors and the larger fruit bats take to heights so that they may plunge fully into open air. Furthermore by far the greatest difficulty in the flight of sea planes is encountered in causing them to rise from the surface, that is, in overcoming the same kind of resistance that flying fish have to surmount.

With these general remarks we may examine the structural qualifications of the Exocoetidae for flight. Considering these fishes from the standpoint of aerodynamics, they may be discussed in the terminology ordinarily applied to the present day aeroplane, the various functions of which are beginning to be well understood and are rapidly becoming standardized. For example, no modern aerodynamical engineer would think of placing the elevating planes of a "normal" craft anterior to the main supporting surfaces (as was first done), on the perfectly sound grounds of safety. Likewise no flying animal that we know of ever developed such a sensitive but unstable arrangement.

Power is applied by flying fishes only as long as they are in contact with the water. That is, after the forepart of the body has been thrust out of the water by rapid swimming and the pectoral fins are spread, very effective power is supplied by the long lower caudal lobe, the only part submerged, combining the advantages of the slight resistance to motion in air with the strong reactive effect of motion in water.[3] As soon as the

[3] Breder, C. M., Jr., Zoologica, 4 (5): The Locomotion of Fishes.

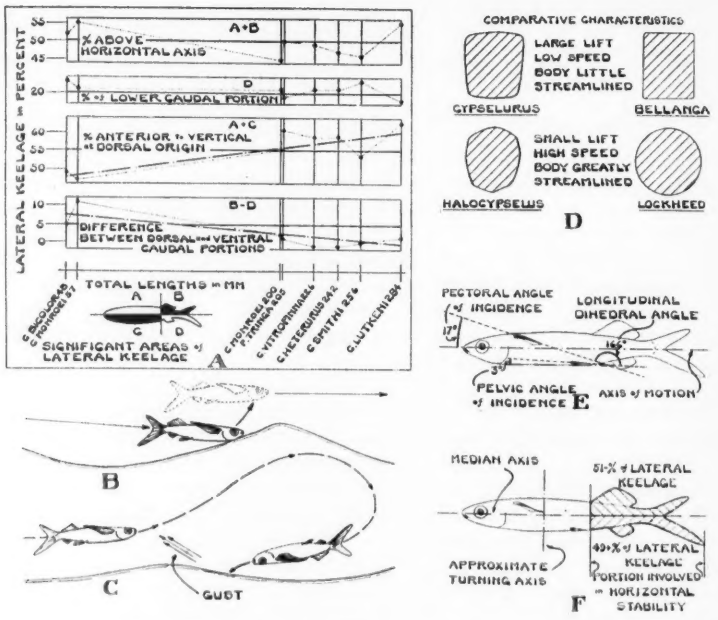


Fig. 1

A. Graphic comparison of the significant lateral keelage areas in eight Cypselurids of various sizes.
B. *Cypselurus* ricocheting from surface.
C. *Cypselurus* making a poor "landing."
D. Comparisons of greatest mid-sections of Exocoetids and standard airplane types.
E. Diagram of elements involved in longitudinal stability as expressed in a *Cypselurus*. Angular figures illustrative only.
F. Diagram of elements involved in horizontal stability as expressed in a *Cypselurus*.

tail leaves the water it immediately stops oscillating, and the fish becomes a glider. Up to that time they may be considered as a pusher type of plane.

The lift, of course, as in the plane, is chiefly obtained by means of an anteriorly placed pair of wings. These are cambered very much as in the modern plane and the support is consequently chiefly from above. According to Dowd,[3] the flying fish wing is so constructed that the upper surface is smooth and flush while the necessary thickness of the supporting rays is all below, which causes the lower surface to be ribbed. This is good construction, the sacrificing of the least efficient surface in the interest of mechanical strength. In the four-winged flyers considerable added lift is given by the ventral fins. In these advanced types the section of the body is squarish, the lower surface acting to increase the lift very much as in a plane built for large lift in which the fuselage takes part. The *Cypselurus*

[3] Dowd, R. E., Aerial Age Weekly, Jan. 10, 1921: 464-465.

type with four wings and a flattened body seems to have gone in for large lift, whereas the *Halocypselus* type with but two wings and a more streamlined body has apparently gone in for speed. These may be directly compared with corresponding fuselage types of modern planes (Fig. 1, D).

Resistance in the air is considerably less in the flying fish than in the plane. The fish requires no landing gear whatsoever and there is a complete absence of external braces and little to produce parasitic resistance. The vertical fins are necessary as stabilizers. The skin friction must be slight on account of the wet and mucus-covered surface.

The inherent stability of flying fishes varies with the type considered. Generally the most advanced flyers show indications of greater stability than the more primitive ones.

Considering longitudinal stability, that is, in regard to a fore and aft pitching, without going into the details of the principles involved, the four-winged types should be much more stable, the ventral fins acting as combination lower planes and stabilizers (Fig. 1, E). They may be considered as stabilizers placed rather far forward and large in proportion to their decreased leverage incident upon such a position or as the lower planes of a biplane type with an unusual amount of stagger. They are set at such a position as to give the proper longitudinal dihedral. Lateral stability is gained as in a plane by some sacrifice of lift by means of a lateral dihedral, that is, a slight tipping of the wings upward (Fig. 2, A).

The horizontal stability is controlled by the lateral keelage, the total surface viewed when examined from the side. Most of this is effective posterior to the insertion of the dorsal fin partly because of position and partly because of its larger area as compared with the remaining anterior part (Fig. 1, F). A fish may be divided into four parts by erecting a vertical at the origin of the dorsal[4] intersecting its longitudinal axis (Fig. 1, A). Designating these "Anterior dorsal," "Posterior dorsal," "Anterior ventral," and "Posterior ventral," it is at once evident that "Anterior dorsal" and "Anterior ventral" are practically identical, whereas "Posterior dorsal" and "Posterior ventral" are not. The percentage above the horizontal axis, "Posterior and Anterior dorsal," as compared with that below, "Posterior and Anterior ventral," is about equal in area, with a slight tendency for that portion below the line to be slightly greater. The average of eight fishes[5] of various kinds shows 52.25% to be below the axis. Comparative measurements with four modern planes[6] in common use show that they average 51% in this respect, a difference of 1¾% which is not as great as the error involved in the methods employed in making these measurements. Neither the percentage above and below the horizontal axis nor the lower caudal portion shows a moving trend with size. The latter region bears little relation to the corresponding part of

[4] More properly such a vertical should pass through the center of gravity, but owing to the difficulty in determining this in preserved material and the fact that the body outlines are practically parallel between such a vertical and the dorsal intersection, for the presnt purposes the latter point will suffice.

[5] These figures are based on the following material (total lengths in mm.): **Cypselurus bicolor** (C. & V.) 48; **C. monroei** N. & B. 57,200; **C. vitropinna** B. 226; **C. heterurus** (R.) 242; **C. smithi** B. & N. 256; **C. lutkeni** J. & E. 284; **Prognichthys tringa** B. 205.

[6] Based on area measurements of lateral keelage including both sides of landing gear of Pitcairn PA-7, Upperecu-Burnelli, Bellanca 1930 Pacemaker and Lockheed Sirius.

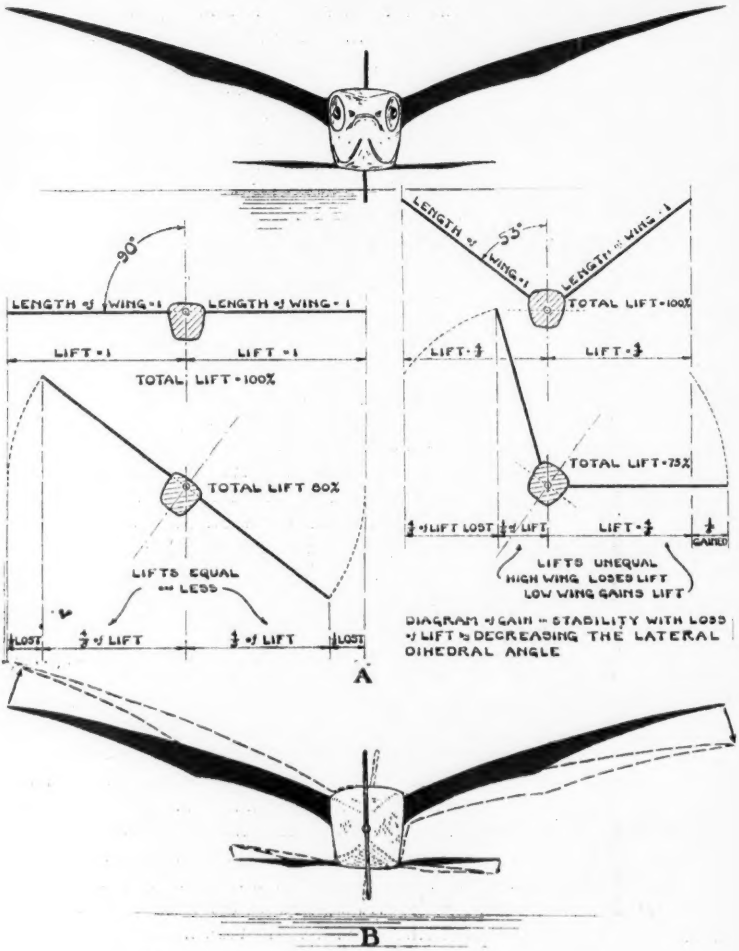


Fig. 2

A. Diagram of elements involved in lateral stability as expressed in a *Cypselurus*, including front view in flight.
B. Diagram of elements involved which give false impression of wing flapping, including rear view in flight.

the plane, as it involves the fish's power plant, whereas in a plane there is only the tiny landing skid. However, if we consider the relation of the part anterior to the vertical to that posterior to it we find that the per cent. anterior rapidly rises from being equal to considerably exceeding the posterior portion in area. In the much larger planes a similar measure-

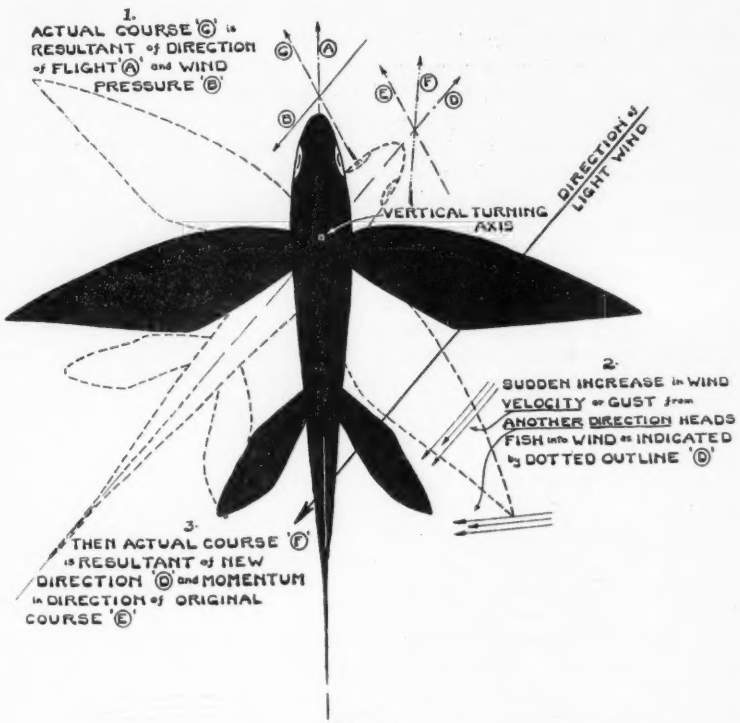

1.
ACTUAL COURSE 'C' is RESULTANT of DIRECTION of FLIGHT 'A' and WIND PRESSURE 'B'
VERTICAL TURNING AXIS
DIRECTION of LIGHT WIND
2.
SUDDEN INCREASE in WIND VELOCITY or GUST from ANOTHER DIRECTION HEADS FISH into WIND as INDICATED by DOTTED OUTLINE 'D'
3.
THEN ACTUAL COURSE 'F' is RESULTANT of NEW DIRECTION 'D' and MOMENTUM in DIRECTION of ORIGINAL COURSE 'E'

Fig. 3

Diagram of lateral reactions in response to changing wind conditions.

ment is still greater, an average of the four planes measured being 80%. The excess of the "Posterior ventral" over the "Posterior dorsal" appears to increase with size, which is to say that the lower caudal lobe (the power plant) becomes relatively larger with an increase in absolute size. Here again we would expect to find no correlation with an aeroplane, and there is none.

Horizontal directional stability is attained by vertical vanes as in a plane and should be much greater in forms with high vertical fins such as *Parexocoetus* than those with low. As this factor rises in importance with the force and erraticness of the wind it may be that those with high vertical vanes fly more in rough weather or inhabit localities of less calm than those with small ones. The position of the longitudinal turning axis is largely dependent on the total lateral keelage. Such forms with most of the lateral keelage above the longitudinal axis would be more stable with that axis inclined upward as in rising, while those with most of it low would be most stable with the longitudinal axis inclined downward, that is, in diving. It is not clear what significance this would have to various

species. In any case the fish acts very much like a weather vane and automatically turns into the wind (Fig. 3). This is doubtless why they usually head into the wind even when starting on another course, which could only be partly maintained by skillful maneuvering.

After a fish once leaves the water it is able to rise higher, holding its level with a decreasing speed by altering its camber and lateral dihedral, or in taking advantage of air currents. There is, of course, a point of maximum efficiency which could be worked out mathematically and would doubtless be close to that actually observed. In this respect fish flight is clearly very close to that of sail-planes. Dowd (1921, *l.c.*) has examined exocoetids in great detail and finds them to be constructed close to the lines used in the best aeronautical engineering.

Shoulejkin[7] has constructed a model of some four-winged type and has determined its characteristics in a wind tunnel. Unfortunately, his model is a poor representation of any flying fish, which doubtless modifies his mathematical results as it certainly does his conclusions. He considers that such fishes have a "step" below the throat, and rise on it in a manner analogous to step bottomed speed boats. There can be little doubt that the performance curves he obtained are much below those to be expected from a properly formed model. Plotting his figures according to Lilienthal's diagram, the stalling or burble point is about 15° with a lift-drift coefficient of 11. From these figures he calculates the possible trajectory at two angles. One of these, however, 20°, is beyond his plotted burble point. However, as these calculated trajectories are insufficient to explain ordinary flying fish flight and merely give the limits of height that they can attain in still air as three and four meters respectively, it is probably permissible. According to further calculations, he shows that his model's performance would be as follows. With an initial speed of 16 meters per second by constantly increasing its angle of incidence, it could maintain a constant level above the water's surface of about 1 meter for 6.2 seconds, and cover 68 meters. A fish should be able to do vastly better than this for several reasons. It has no impeding step such as was built on Shoulejkin's model, it is smoother, and offers less skin friction and probably needs not nearly such a high speed or large angle of incidence in getting under way. Shoulejkin's work, nevertheless, demonstrates from a dynamic standpoint the ability of fishes to fly without referring to wing flapping as has so frequently been done. Dowd's work demonstrates from a structural or static standpoint the same facts. Much observation by the first of these investigators and the author afield, bear these engineering principles out in full.

As previously mentioned, planes or fishes with a small lateral dihedral have a maximum lift and a minimum of stability. At starting from the surface a maximum lift would free them from the water more rapidly. Extensive observations at the Carnegie Station at the Dry Tortugas, Florida, in 1929, from small boats close to the surface showed this to be true

[7] Shoulejkin, W. Sonderdruck aus Internat. Revue der ges. Hydrobiol u. Hydrographie, 22 (1-2), 1929: 102-110.

and what superficially might be construed as a wing flapping when viewed diagonally from above is clearly a rolling on the longitudinal axis usually with a very short and abrupt period of oscillation (Fig. 2, B). That is, one wing goes up as the other descends, which, of course, precludes flapping as a mode of locomotion at such times. Regarding the very young of two inches and less, there is no such certainty, for although all that the author ever saw them do was to glide like paper darts[8], J. T. Nichols reports having seen their wings vibrate like those of a grasshopper.[9]

In the making of these field observations many odd accidents of flight were seen to occur. Indeed, it has been wondered if flying fishes are more skillful than the average plane pilot. A common thing to occur is for the descending fish to strike an oncoming wave at a certain angle and bound into the air like a stone being skipped, and fly on again (Fig. 1, B). This might be taken as intentional, although it is doubted, as ordinarily the tail is dropped and sculling is commenced for the purpose of extending the time aloft, whereas the normal descent is usually head first, although what would be good three-point landings in a plane are not uncommon. Bad landings too are not rare. The worst ever seen by the author was that of a fairly large fish that was evidently caught in a sudden gust of air or had badly maneuvered, making a partial loop and landing upside down (Fig. 1, C). Accidents disastrous to a plane are only minor incidents in the life of a flying fish, and consequently there is little incentive for them to develop such relatively efficient landing methods as have the birds.

New York Aquarium, Battery Park, New York City.

[8] **Cypselurus furcatus** and **Parexocoetus mesogaster**.
[9] Species undetermined. See Breder, l. c.

Embryonic Development of the Labrid Fish Oxyjulis californicus Günther

By Rolf L. Bolin

FISH embryology, descriptive as well as experimental, is practically a virgin field on the west coast of America. The coastal waters of California are, at all seasons, rich in pelagic fish eggs, the great majority of which at present defy any attempt at specific determination. Most of the eggs are, indeed, impossible to assign even to the proper family. The present paper makes no pretense at adding anything essentially new to the field of teleostean embryology. It is simply an attempt to cast light upon one of these many unknown eggs of the California coast, in order to make possible its future specific identification and a fairly accurate estimation of age at any stage until hatching. All observations were made upon living material.

Accurate delimitation of the spawning season of *Oxyjulis californicus* is at present impossible but data at hand indicate that it extends from the latter part of May well into October, and that July and August constitute the height of the season.

The mature, unfertilized eggs have a specific gravity which is slightly less than that of sea water, and as a result they float at or near the surface. As is true of all pelagic fish eggs, they normally float with the vegetal pole uppermost. All of the accompanying figures represent the eggs in this position, and are either lateral views or show the aspect of the vegetal pole as seen from above.

The eggs are spherical in form and have a diameter of 0.74 to 0.79 mm. The egg membrane is thin and horny. Between it and the yolk, there is a barely perceptible perivitelline space. Embedded in the yolk at the vegetal pole is a single large oil globule about 0.15 mm. in diameter and of a characteristic orange pink color. This coloration of the oil globule is somewhat unusual in fish eggs and is, therefore, a valuable diagnostic character during the early stages. The only body of protoplasm which can be distinguished in the unfertilized egg is a small, cap-shaped mass covering the lower pole of the oil globule.

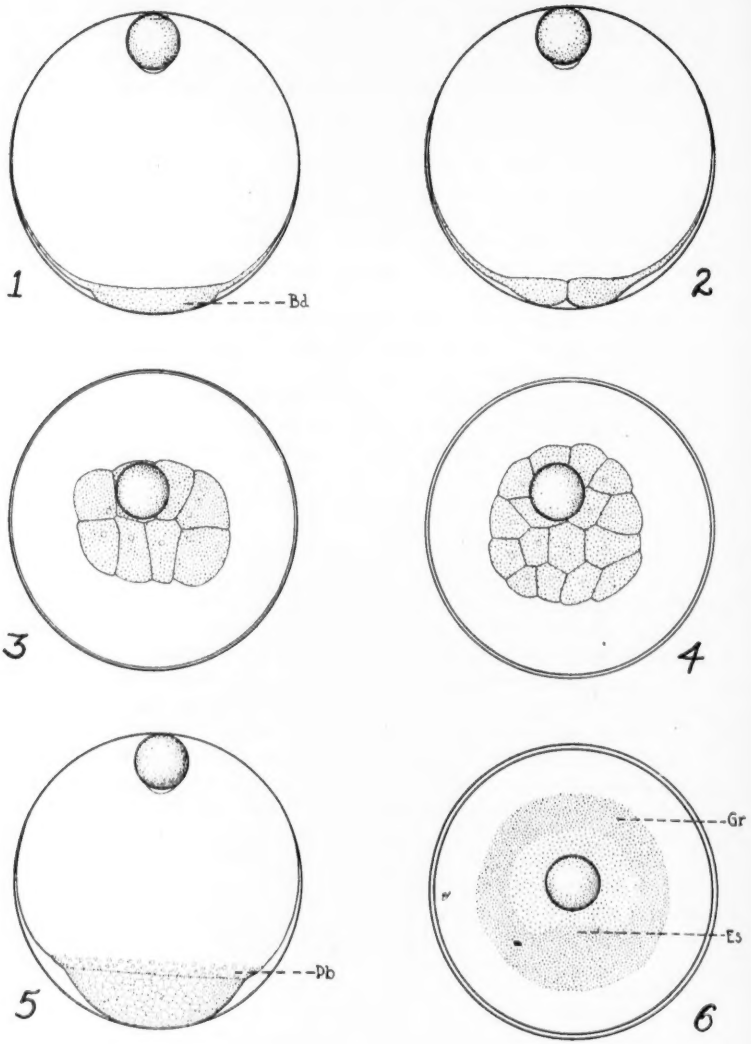
As soon as fertilization has taken place, the protoplasm of a thin and hitherto imperceptible layer investing the yolk begins to concentrate at the animal pole to form the blastodisc. The streaming by which this is accomplished, and which has been described by Ryder (1884) for the cod egg, is very difficult to observe in the species under discussion, due to the small size of the protoplasmic granules, but it is suggested by faint wavy irregularities which are barely distinguishable under perfect lighting conditions. As the concentration progresses, it becomes evident that the protoplasm is not colorless: the fully developed blastodisc is an orange pink, similar in color to the oil globule but much paler.

The blastodisc reaches its full development a little less than an hour after fertilization (Fig. 1). It is circular in outline, of nearly uniform thickness throughout its larger extent and has rather abruptly sloping edges. The surface overlying the yolk is flat, while the opposite surface, pressing against the egg membrane, is gently convex. Peripherally the protoplasm of the blastodisc is continuous with the sheet of protoplasm covering the yolk, which at this stage is imperceptibly thin at the vegetal pole but of appreciable thickness over the lower half of the yolk sphere.

The first cleavage occurs about one hour after fertilization and subsequent cleavages follow at intervals of one half hour or slightly less. As the moment for cleavage approaches, the blastoderm becomes somewhat elongated at right angles to the first cleavage plane. The first cleavage is meridional and results in two large, subequal cells (Fig. 2). During divisions, the cleavage furrows cut deeply into the blastoderm. As a result the blastomeres show a strong tendency to assume a spherical shape. This tendency is expressed in a bulging of the differentiating cells into the yolk mass and a general steepening of the sides of the blastoderm. Shortly after cleavage is complete, the bulges into the yolk become flattened and the sides of the blastoderm assume a more gentle slope. This phenomenon, very marked during early cleavages, becomes less pronounced in later blastoderm stages.

The second cleavage, also meridional, takes place at right angles to the first and results in a restoration of the equality of the two axes of the blastoderm. The third cleavage takes place on either side of, and parallel to, the first plane of cleavage, and results in the formation of two parallel rows, each of four blastomeres (Fig. 3). This again effects an elongation of one axis of the blastoderm. At this time, irregularities in the size and shape of the individual cells frequently occur. With the fourth cleavage the blastoderm again becomes roughly circular in outline but disparity in size, shape and position of the cells is usually increased (Fig. 4). Most of the blastoderms are not irregular in outline but only in the size and arrangement of the component blastomeres. Some, however, have single cells projecting like appendages from the central mass. A few blastoderms appear almost ideally symmetrical. Subsequent cleavages, reducing the size of the blastomeres, also reduce the visible irregularities and, as development progresses, the blastoderms become increasingly symmetrical. With the fifth cleavage and the consequent establishment of thirty-two cells, the blastoderm becomes two cells in thickness and further cleavages become increasingly difficult to follow in the living material.

During early cleavages, the protoplasm investing the yolk continues to flow into the blastoderm which thus increases in bulk and assumes the form of a dome resting upon the yolk mass; however, its marginal cells still remain continuous with the residual thin film of extra-blastodermal protoplasm. Ultimately most of this thin layer of protoplasm becomes concentrated in a flat, non-cellular rim encircling the margin of the blastoderm. Nuclei, derived from the marginal cells of the blastoderm, soon become evident in this flattened rim and increase in number until they are thickly distributed throughout its mass. This syncytium, known as the


1
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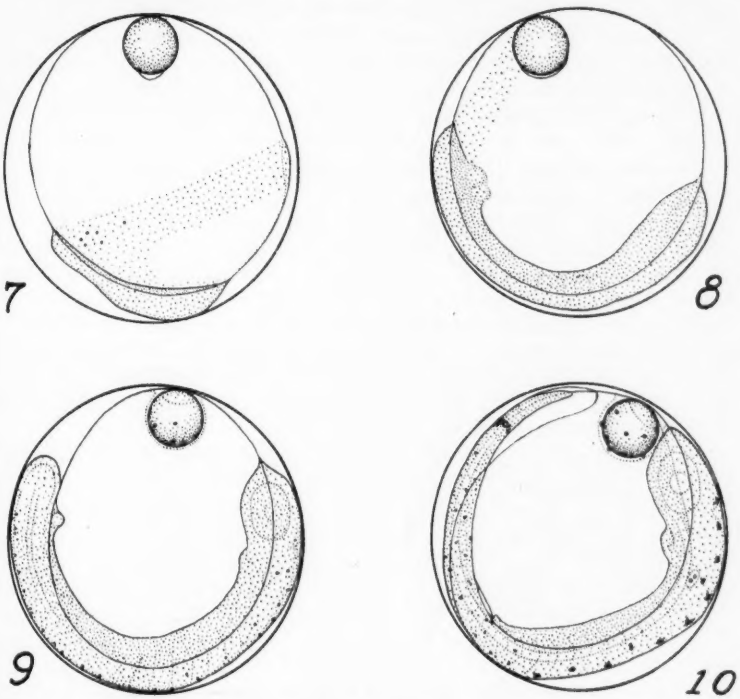

Fig. 1. Fertilized egg with fully developed blastodisc (Bd).
Fig. 2. Egg with blastoderm of two cells.
Fig. 3. Egg with blastoderm of eight cells.
Fig. 4. Egg with blastoderm of sixteen cells.
Fig. 5. Egg with blastoderm in late cleavage stage and periblast (Pb) well developed.
Fig. 6. Egg with germ ring fully differentiated and embryonic shield (Es) beginning to develop.
Fig. 7. Egg showing advanced stage in differentiation of embryonic axis.
Fig. 8. Egg shortly before closure of blastopore, showing embryo with two Kuffer's vesicles.
Fig. 9. Egg at twenty-four hours, showing advanced embryo.
Fig. 10. Egg with advanced embryo, a few hours before hatching.

periblast, is well developed about seven hours after fertilization (Fig. 5).

As development progresses, the marginal cells of the blastoderm become completely cut off from the periblast and soon afterward the latter structure fades from view. Its fate can not be determined in the living material but has been discussed at some length by Wilson (1891) for the sea bass.

At about the time of the disappearance of the periblast, the segmentation cavity becomes evident under the central area of the blastoderm. It is formed by a thinning of the central blastodermal wall, by reason of which the surface adjacent to the yolk becomes decidedly concave. Due to this thinning of the central area, there is differentiated a thicker peripheral zone of the blastoderm, and this zone becomes strengthened by rapid proliferation and centripetal growth of the marginal cells. The resulting thickened, cellular wall is known as the germ ring. It appears as a broad, opaque ring surrounding a more transparent area, and from the time of its origin until the closure of the blastopore, it marks the advance of the blastoderm over the yolk sphere.

As soon as the germ ring is well differentiated, which is ten or eleven hours after fertilization, it may be seen to be wider at one point than elsewhere (Fig. 6). Here invagination takes place more rapidly than around the rest of the periphery of the blastoderm and this point marks the posterior pole of the future embryo. The very rapid proliferation of cells at the posterior pole results in a broad tongue, the embryonic shield, being formed and pushed forward into the segmentation cavity. The embryonic shield gradually assumes the form of a roughly triangular, blunt-nosed wedge. Its increase in size is accompanied by a thickening along its median line. This thickening, which advances from the posterior pole of the blastoderm, represents the axis of the future embryo. The thickening forms a narrow longitudinal ridge which protrudes dorsally into the perivitelline space and is embedded ventrally in the yolk (Fig. 7). Although the linear thickening of the embryonic axis advances from the posterior pole, the differentiation of the embryo begins anteriorly: the head region soon becomes broader than the posterior region. During the formation of the embryonic axis, the blastoderm displays an accelerated growth and at fourteen or fifteen hours covers almost half of the yolk sphere.

At about the time the germ ring forms an equatorial belt around the yolk, the eyes become visible and Kupffer's vesicle appears, embedded in the yolk near the posterior end of the embryo. A remarkable peculiarity in the development of this species was observed at this point. In about fifty per cent. of the eggs examined, two Kupffer's vesicles were developed, each of about the same size as the single vesicle in other eggs of the same batch. The obvious suggestion is, of course, that the development of two vesicles represents an irregularity resulting from the abnormal conditions of laboratory environment. The question must be left open until further evidence is available. However, I wish to emphasize that during the past two years, hundreds of eggs of many different species of teleosts have been hatched by the writer under conditions apparently identical with

those to which the eggs of *Oxyjulis* were subjected, but in no other species has a duplication of Kupffer's vesicle been observed.

Shortly before the closure of the blastopore, at about eighteen hours after fertilization, metameric segmentation may be detected, appearing first near the middle of the embryo and later developing farther anteriorly and posteriorly (Fig. 8). Immediately following the closure of the blastopore, practically all of the structures visible in the living embryo become differentiated (Fig. 9). First the pupils of the eyes become visible and a little later the auditory capsules appear as small oval vesicles just posterior to the eyes. Concomitant with the differentiation of these structures, the notochord also becomes apparent, and the heart, protruding into the yolk just behind the head, begins to pulsate. Kupffer's vesicle persists after the closure of the blastopore but declines in size and disappears after a few hours.

The oil globule, which is orange pink in the early stages, begins to grow noticeably paler at about the time of the formation of the embryonic shield and by the time the blastopore closes, or shortly thereafter, it becomes entirely colorless. Concurrently, the protoplasmic cap of the oil globule spreads out to form a thin layer of protoplasm covering the entire globule.

At about twenty-four hours, pigment begins to appear in the form of small melanophores arranged in an irregular, double series along the dorsal side of the embryo, and scattered sparsely over the lower half of the oil globule. By this time practically all of the main features of the embryo can be seen and the further gross development consists largely of a rapid increase in the length of the tail. The tail, which becomes free shortly after the blastopore is closed, soon begins to twitch spasmodically from side to side, and it may then be observed that the delicate, continuous fin fold is already formed, extending from the nape to the vent. The elongation of the tail continues until the embryo has more than encircled the entire yolk, and the tip of the tail comes to lie across or near the head.

While the changes just mentioned take place, a slight development of the melanophores occurs. As previously stated, they are first arranged in a double series along the dorsal side of the embryo. They do not extend anterior to the eyes nor do they quite reach the tip of the tail. As the embryo develops, these pigment cells, small and inconspicuous when they first appear, enlarge and become amoeboid in form on the anterior half of the embryo. Posteriorly they increase very little in size but here they soon assume a very irregular arrangement and finally come to be scattered sparsely over the entire body. A few of them concentrate to form a fairly conspicuous cross bar a short distance from the tip of the tail (Fig. 10). The melanophores of the oil globule become somewhat more numerous and increase in size. They may appear as large greyish black amoeboid cells but more frequently they are contracted and then appear as small jet black knobs arising from the surface of the oil globule.

As the time for hatching approaches the embryo becomes more active; the jerkings of the tail sometimes result in the entire embryo rolling over within the egg membrane. At about forty-eight hours the capsule is ruptured and the larva liberated.

As a final remark it may be noted that the time required for the hatching of *Oxyjulis* is decidedly less than for any other Californian fish egg thus far examined. For all other species the period required is at least three days. However, *Oxyjulis,* by no means, represents the most rapid development observed in marine fishes, as Kuntz (1915) states that *Anchovia mitchilli,* from the Atlantic coast, completes its embryonic development in twenty-four hours.

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HYDROBIOLOGICAL SURVEY, HOPKINS MARINE STATION, PACIFIC GROVE, CALIFORNIA.

On the Probable Identity, Life-history and Anatomy of the Free-living and Attached Males of the Ceratioid Fishes[1]

By A. E. Parr

SHORTLY after having finished a study of the osteology of various genera of the aceratiid family of ceratioid deep-sea fishes, the writer was, by general considerations, led to suspect that the family in question might in reality represent merely the free-living stages of the males which have heretofore only been known to science through Mr. C. Tate Regan's amazing discoveries[2] of various more or less degenerate specimens attached in a presumably parasitic fashion to the skin of the much larger females. No such large females have ever been found in the family Aceratiidae; the latter, on the contrary, are exclusively known from a considerable number and variety of very small forms comparing very well with the parasitic males in regard to size. There is no record of any aceratiid "species" ever having been found to attain even to a total length as great as 50 mm.: the usual sizes vary between 20 and 35 to 40 mm., of which one-fourth to one-third is represented by the caudal fin. (The attached males vary in length from 10 to 105 mm., on females of various forms from 62 to 1030 mm. long.) The Aceratiidae further agree with the attached males in the absence of the free external illicium characteristic of all other groups of Ceratioids (all female ceratioids?). As previously shown by the writer[3] the illicium of the Aceratiidae has not become lost, however, but modified into an internal rostral bone of a pincher-like structure, which, particu-

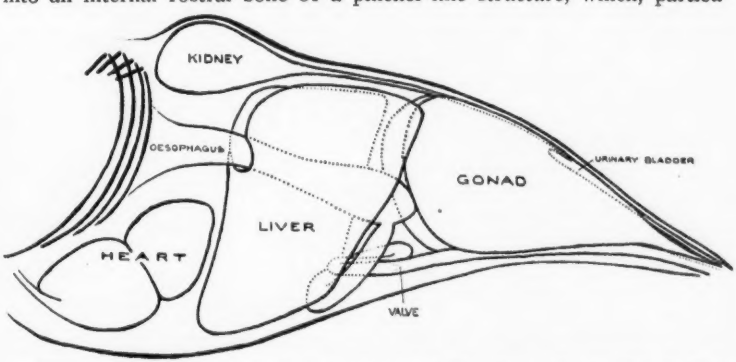


Figure 1. Diagram of the visceral anatomy of *Rhynchoceratias longipinnis* Parr. Reconstructed from serial sections.

[1] Contributions from the Bingham Oceanographic Laboratory, No. 21.
[2] Proc. Roy. Soc. London, (B), 97, 1925: 386-400 (reviewed by David Starr Jordan in Scientific Monthly, 22: 367).
[3] Occ. Pap. Bingham Oceanogr. Coll., No. 3, Feb. 1930.

larly in the genus *Rhynchoceratias,* may certainly be said to be strongly suggestive of an organ for attachment harmonizing remarkably well with the manner in which the parasitic male ceratioids have been found to be attached to the females.

With these considerations in mind, the entire contents of the abdominal cavity was carefully dissected out of the type specimen of *Rhynchoceratias acanthirostris* Parr[4] and made into a complete series of transverse microsections. As will be seen from the accompanying diagrammatic reconstruction (Fig. 1) and cross-section view (Fig. 2) the gonads have already reached a relative size which is very hard, or rather quite impossible, to reconcile with any possibility of their still being in a quite immature and undifferentiated stage, on the contrary rather suggesting an already attained or rapidly approaching maturity. On this assumption of a fairly advanced stage of maturation the preparations at hand, although poorly preserved for histological purposes, are clearly in accordance with the appearance of a testis and its products, and show no similarity whatever

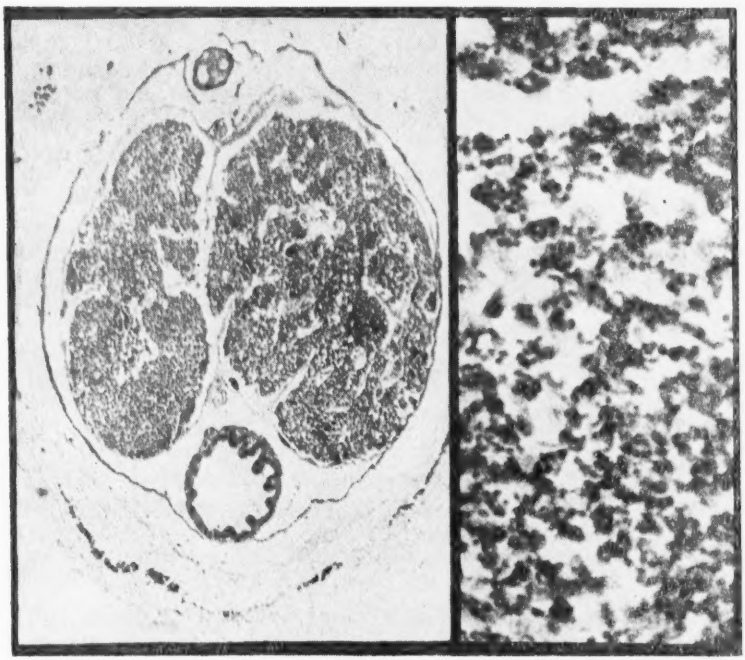


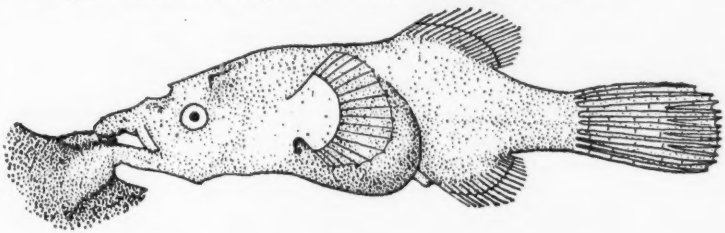
Figure 2 (left). Photomicrograph of a cross-section through the gonad of *Rhynchoceratias longipinnis* Parr.

Figure 3 (right). Structure of testis of *Rhynchoceratias longipinnis* Parr. Photomicrograph of portion of cross section, enlarged 700 times.

[4] Bull. Bingham Oceanogr. Coll., 3(3), 1927:31.

with the picture to be expected in cross sections of an ovary grown to the same proportions (see Figs. 2 and 3).

Realizing, however, that the argument would still seem questionable, the writer has heretofore been in considerable doubt about whether to advance it or not until conclusive evidence for the relationship of a parasitic male to the free-living forms included in the family Aceratiidae, more particularly in the genus *Rhynchoceratias*, came to hand by the receipt of Dr. Regan's most recent report on a male attached to a female.[5]



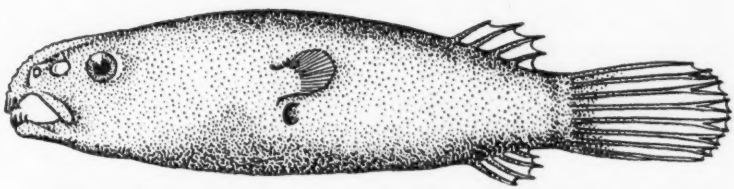


Figure 4 (above). Parasitic male of *Caulophryne polynema* Regan. After Regan, *loc. cit.*, 1930: fig. 3.

Figure 5 (below). *Rhynchoceratias oncorhynchus* Regan. After Regan, *loc. cit.*, 1926: pl. 13, fig. 3.

As described and illustrated by Regan, the male in question, detached from its female, becomes in all significant respects a perfectly characteristic representative of the genus *Rhynchoceratias*. For better comparison, Regan's figure is herewith reproduced (as Fig. 4) together with the same author's earlier[6] illustration of the free-living *Rhynchoceratias oncorhynchus* (Fig. 5). Minor differences will be seen in the numbers of dorsal and anal fin rays (D. 19, A. 16 in the parasitic male; D. 4, A. 4 in *R. oncorhynchus*) but free-living representatives of the genus *Rhynchoceratias*, with much higher fin ray counts (D. 10 to 12) than those of *R. oncorhynchus*, have already previously been described by the present writer (*loc. cit.*, 1927: 31-32; 1930: 7), and these differences can therefore not be considered at all significant, beyond specific distinctions, compared with the complete agreement between the parasitic male and the free-living forms in all other morphological respects, so far as known; most particularly in

[5] Jour. Linn. Soc. London, 37, August, 1930: 191.
[6] The Danish "Dana" Expeditions 1920-22, Oceanogr. Rep. No. 2, Copenhagen, 1926: pl. 13, fig. 3.

the very peculiar and highly specialized development of the rostral structures. Both figures show the reduced premaxillaries and maxillaries in the same characteristic, oblique position, incapable of closing against the lower jaw; both show the same development of a strong rostral structure anterior to the premaxillaries, and both show the lower jaw enlarged and produced in the same manner to meet this rostral structure instead of the premaxillaries. The rostral bone in question has, as already mentioned, previously been shown by the writer (*loc. cit.*, 1930) to be the homologue of the illicium of the ceratioids other than the Aceratiidae (the females as a whole?), representing, in other words, a very extreme modification of the most anterior dorsal fin-ray (spine). The accompanying figure of the anatomy of the snout in a free-living *Rhynchoceratias,* seen in oblique dorso-lateral view (Fig. 6), makes this relationship clear, and will also serve to make the comparison with Regan's illustration of the attached male even more obvious and convincing. As a special detail further confirming the general concordance between the two may be pointed out the presence of median rostral spines in the attached specimen (see Fig. 4) as well as in all species of *Rhynchoceratias,* while similar spines have not been found among any ceratioid fishes outside of the family Aceratiidae.

While strongly averse to accepting an adaptivistic interpretation as anything but a pseudo-explanation of morpho-biological phenomena, the writer cannot avoid seeing how easily the observations here set forth might lend themselves to speculations of an adaptivistic nature, inasmuch as the

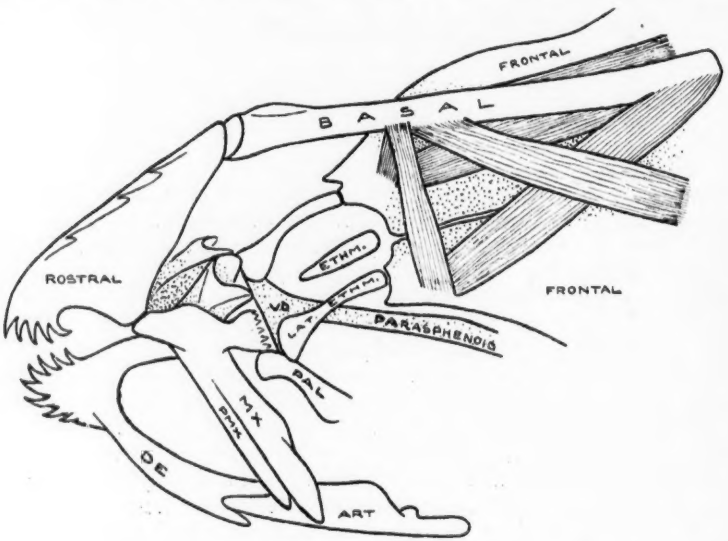


Figure 6. Oblique dorso-lateral view of the anatomy of the snout in *Rhynchoceratias longipinnis* Parr.
Modified from Parr, *loc. cit.*, 1930: fig. 3.

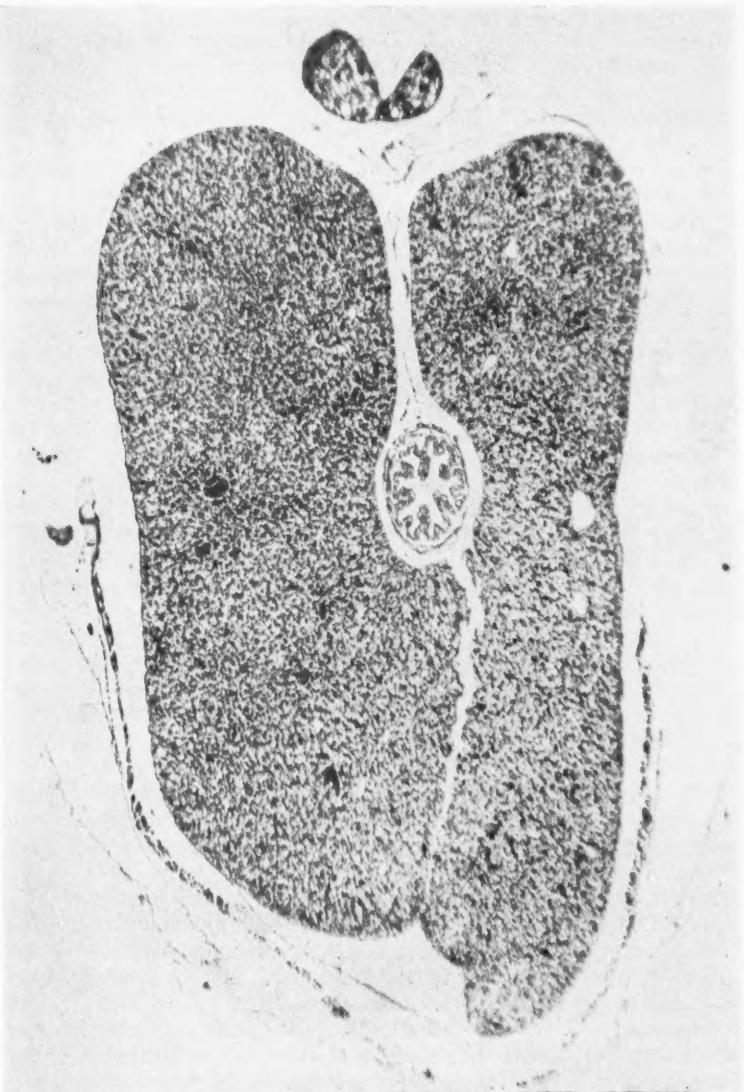


Figure 7. Photograph of a cross section through the body cavity of *Rhynchoceratias longipinnis* Parr.

Showing the anterior portions of stomach and liver, and the posterior parts of the kidneys. The division of the ventral part of the liver is artificial.

very identical organ, which in the female might be assumed to serve as a luminous lure for attracting the males, in the latter sex has become modified to perform the mechanically entirely dissimilar reaction of attachment, by which the male responds to this very attraction of the female. An arrangement of this kind might certainly be regarded as an example of extreme phylogenetic economy of morphological parts, although the attained economy can not legitimately be considered as a true phylogenetic cause for its own existence.

In regard to the further anatomy of the body cavity of the free-living male (*Rhynchoceratias*) a few observations may be in place. The viscera as a whole are characterized by the very small size and poor development of the alimentary canal, in which respect the investigated specimen is quite concordant with Regan's observations on the parasitic male, and by the enormous size and development of the liver (see Figs. 1 and 7). The intestine consists of a short descending branch and a small double loop, coiled in the horizontal plane in the ventral portion of the body cavity, and opens through a simple conical valve into the rather long, straight rectum. The kidneys are rather large, pear-shaped and situated far forward. The mesonephric ducts empty into an elongate urinary bladder. The rectum, genital and urinary ducts remain separate from each other to the end of the preserved series, and, while a few of the very ultimate sections are absent, it is obvious that there can neither have been room for a cloaca, nor for an urino-genital sinus to have been formed. The heart is rather large and well-developed.

Several important conclusions on the probable life history of the male ceratioids may be drawn from the observations recorded above, on the visceral anatomy of *Rhynchoceratias* if the hypothesis, that this genus and related aceratiid genera represent the heretofore unrecognized free-living stages of the parasitic males, is taken for granted on the basis of the evidence advanced in the preceeding discussion.

In his first discussion of the attached males, Regan (*loc. cit.*, 1925: 396) suggests that "unless the attachment is followed by extensive degeneration of the alimentary system, it must take place very early, at the end of the larval stage." That this is at least not commonly realized is at once obvious from the much more numerous records of free-living and fully developed representatives of *Rhynchoceratias* than of the attached males. The rather reduced state of the alimentary canal already achieved in the free-living stage also greatly reduces the assumed amount of degeneration required to bring this organ system into the rudimentary condition in which it was found by Regan in the parasitic male of *Ceratias holbolli*. For better comparison on this and the following points, Regan's illustration of the visceral anatomy of a female *Cryptosparas couesii* (*loc. cit.*, 1925: 393, fig. 5) is reproduced in the accompanying Fig. 8. The relatively large size already attained by the male gonads of *Rhynchoceratias acanthirostris* further shows the development of the testes to be at least to a very considerable extent not dependent upon the attachment to a female. In the enormous development of the liver in *Rhynchoceratias* (compare Figs. 1 and 7)

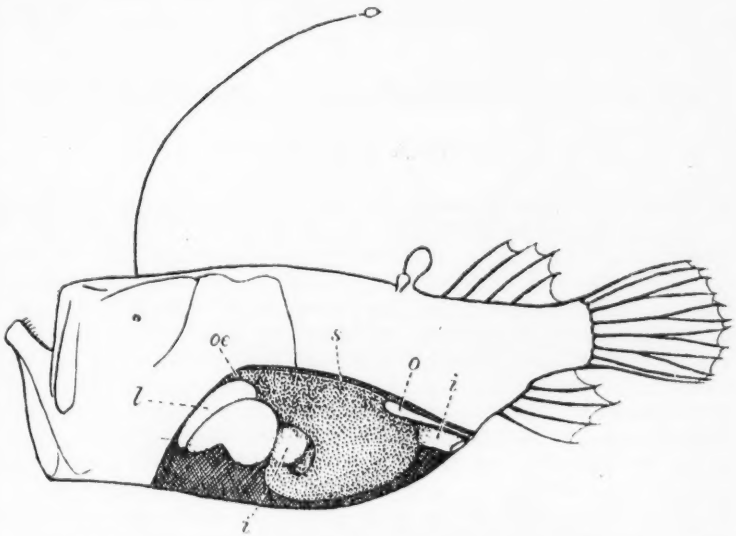


Figure 8. Visceral anatomy of *Cryptosparas couesii*, female. After Regan, 1925: fig. 5.
i, intestine; l, liver; o, ovary; oe, oesophagus; s, stomach.

we may finally see an indication that the parasitism assumed to exist in connection with the attachment to a female may perhaps play a much less important role in the peculiar relationship between the two sexes than originally suggested by Regan (1925: 396), in his statement that the "growth of the male fish would then be accomplished entirely through the nutrition derived from the female through the blood." The enormous size of the liver, particularly in comparison with the greatly reduced alimentary canal, is, under the circumstances, much more easily understood in relation to the food storage properties of this organ than in relation to its digestive functions, and it may not be unreasonable to assume that its own liver, not the blood of the female, may be the most important factor in sustaining the life and further growth and maturing of the male after it becomes attached to a female. Through the established contact a mutual or one-sided control of the final stages of maturation and the actual discharge of the genital products may take place, as already suggested by Regan, but from the considerations here presented we are led to suspect on the contrary that the very peculiar relationship between the sexes in ceratioid fishes may be more a matter of a highly specialized and extended mating act than a phenomenon of actual parasitism.

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A Note on the Classification of the Stomiatoid Fishes

By A. E. Parr

In a previous paper[1] the writer has attempted to show that the genus *Stomias* can not be regarded as directly related to the various other genera usually referred to the family Stomiatidae (and to the families Astronesthidae and Idiacanthidae) and a new family, Melanostomiatidae, and suborder, Gymnophotodermi, were therefore introduced for these latter forms, while the suggestion was made that the family Stomiatidae should be limited to the genera *Stomias* and *Macrostomias,* only, and excluded from the suborder Gymnophotodermi. This suggestion has not been followed by Regan and Trewavas in their more recent treatise on the same systematic group of fishes,[2] but in their discussion of the anatomy of the Stomiatidae (as the family is interpreted by them) we nevertheless find the arguments already previously advanced by the present writer in favor of a separation of the genus *Stomias* strongly confirmed in the statement: "*Stomias* is distinguished from the other genera especially by two features, one primitive, the presence of scales, and the other in this group a specialized character, the praemaxillaries free from the maxillaries" (Regan and Trewavas, *loc. cit.*, p. 38). The writer will therefore merely again point out that it is contrary to the principles of a natural classification to combine within one systematic unit various groups of forms expressing crossing tendencies of phylogenetic differentiation in their comparative morphology, i.e., which show a mixture of primitivity and specialization in relation to each other, instead of consistent primitivity, on one hand, coupled with a consistently more specialized anatomy on the other. It is therefore again suggested that the Astronesthidae and the Melanostomiatidae[3] be combined in the suborder Gymnophotodermi, as previously proposed, while the Stomiatidae, *sensu stricto,* be limited as above indicated and referred to a separate suborder, for which the name of ***Lepidophotodermi*** is herewith suggested. The Lepidophotodermi, may at least provisionally, also be made to include the Chauliodontidae, although the position of this family relative to the other stomiatoids seems rather uncertain. A third suborder, the ***Heterophotodermi,*** could then embrace the Gonostomatidae and the Sternoptychiidae.

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[1] Bulletin Bingham Oceanogr. Coll. 3(3): 15-17. 1927.
[2] The Danish "Dana"-Expeditions 1920-22. Oceanogr. Rep. No. 6, 1930.
[3] The writer is in perfect agreement with Regan and Trewavas that, in accordance with their observations on its anatomy, the genus Idiacanthus should now be included among the other genera here referred to the Melanostomiatidae. The family Idiacanthidae is therefore omitted.

Miscellaneous Observations on Fishes of Washington

By Leonard P. Schultz

DURING the past two years of residence in the state of Washington, a considerable amount of my time has been devoted to collecting and studying the local fish fauna. The summer of 1930 was spent at Friday Harbor, Washington, for the collection and study of Puget Sound fishes; 76 species were taken. Dr. T. C. Frye, Director of the Puget Sound Biological Station, kindly granted the author permission to make these collections.

It seems fitting at this time to put on record a few observations concerning the distribution and habits of certain marine and freshwater species of Washington. The material referred to is preserved in the fish collection of the Department of Fisheries of the University of Washington.

1. *Lampetra fluviatilis* (Linnaeus)

This parasitic brook lamprey is represented in our collection by a single adult specimen, taken in Lake Washington near Seattle by Prof. Trevor Kincaid, in 1914. Although most of the tributaries entering this lake have been watched closely for spawning individuals, no specimen was observed. *Lampetra planeri*, however, is abundant in all the adjacent lowland streams. *Entosphenus tridentatus* is not abundant in the tributaries of Puget Sound, but is very common in the coastwise streams, which empty directly into the ocean.

2. *Alepisaurus ferox* Lowe

The lancet fish may be considered as a species of regular occurrence in the North Pacific off the coast of Washington, to judge from numerous records (see Crawford, Copeia, No. 147, 1925, and No. 171, 1929), and from the specimens sent to us for identification each year by halibut fishermen. These captains tell us that they have caught from two to six specimens or more yearly, but have cast them overboard. It is of interest that no small ones have been taken; the average length is from 3½ to 5 feet. Perhaps selective fishing will account for the absence of smaller specimens.

3. *Novumbra hubbsi* Schultz

The western mud minnow has been collected only from its type-locality near Satsap, Washington,[1] where it is locally abundant during the rainy season. But during the summer, this ditch dries up, is dusty, and all grasses wither and turn brown. Even at a depth of one foot below the bottom of the drainage canal no trace of moisture was evident during the first week

[1] Leonard P. Schultz, Description of a new type of mud minnow from Western Washington with notes on related species. Pub. Fish., Univ. Wash., 2 (6), 1929: 73-82.

of September, a condition impossible for the support of fish life, thus eliminating the suggestion that *Novumbra* may bury itself and astivate. The nearest permanent pools or sloughs are located almost a mile away. These fish probably live during the dry season in these permanent sloughs, but their capture is difficult owing to the brush filled condition of the waters. However, soon after the winter rains begin, and the drainage ditches are party filled, *Novumbra* makes its appearance. The author and Dr. E. V. Smith collected 24 specimens on December 30, 1929, when a few individuals of *Novumbra* were observed to swim in such shallow water that their dorsal fins broke through the surface, although the majority of individuals were in the deeper holes of this drainage canal.

Both sexes of *Novumbra* are brilliantly colored while living in this drainage ditch. The females are distended with eggs as early as November, and as late as February 24. The young *Novumbra* have been taken from this ditch in June but not later. It is concluded that the young of the year leave this ditch before late June or they would be trapped in the pools, destined to dry up in a few weeks. The only nearby permanent pools which exist are those occurring along the marshland of the Chehalis River, into which the ditch drains where the mud minnow probably lives and matures. It appears that our western mud minnow upon reaching sexual maturity migrates into this ditch during the rainy season for spawning purposes, and spends the dry season in the poorly drained marshland and sloughs near the Chehalis River.

Novumbra hubbsi is of course an addition to the list of fresh water fishes of Oregon and Washington.[2] Attention is called to a very important reference[3] on the osteology of *Dallia pictoralis*, overlooked by the author in the description of *Novumbra*.

4. *Icosteus aenigmaticus* Lockington

One specimen of the rag fish was taken in a commercial salmon seine near the mouth of the Columbia River at Ilwaco, by E. C. Fimmer, on August 12, 1926. This specimen was captured in shallow water over sandy bottom, under conditions similar to those reported by A. L. Pritchard.[4] Since *Icosteus aenigmaticus* was not listed by Hubbs,[5] it may be considered as another addition to our Oregon and Washington fauna.

5. *Pomoxis sparoides* Lacépède

This species, not recorded in my freshwater checklist cited above, has been found to occur abundantly in Lakes Washington and Union near Seattle.

6. *Jordania zonope* Starks

This remarkable cottoid occurred rather commonly on the more exposed shores of San Juan Island, among the rocks in low tidal pools, where eight

[2] Leonard P. Schultz, Checklist of the Fresh Water Fishes of Oregon and Washington. Publ. Fish. Univ. Wash., 2 (4), 1929: 43-50.
[3] E. C. Starks, The Osteology of Dallia pictoralis. Zool. Jahrb, (Abth. Syst.), 21, 1904: 249-262.
[4] A rag fish (Icosteus aenigmaticus) from Queen Charlotte Islands. COPEIA, No. 171, 1929: 38.
[5] Carl L. Hubbs, Checklist of the Marine Fishes of Oregon and Washington. Jour. Pan-Pac. Res. Inst., 3(3), 1928: 9-16.

brilliantly colored adult specimens were collected during the summer of 1930 by the author. One pair each was taken from four isolated tidal pools. In addition to these, one very small specimen was captured on July 23 in a shrimp trap placed off Brown Island near Friday Harbor, at a depth of sixty feet. These specimens were very similar in color to those described by Starks.[6]

7. *Rusciculus rimensis* Greeley

One specimen of this cottoid, along with three specimens of *Oligocottus maculosus,* were given to me by Dr. Victor E. Shelford, who collected them from a high shallow tide pool on the exposed outer shore of Vancouver Island, in Barclay Sound on July 29, 1930. Another specimen was taken from a low tide-pool at Kanaka Bay, San Juan Island, on June 28, and 17 others were collected in a tide-pool at the entrance of False Bay, on the same island, on July 26 and 27. Numerous records, (see Hubbs, 1926)[5] indicate that this species is not especially rare along the exposed coast as far north as Gabrolia Island, British Columbia. This evidence is substantiated by the male and female specimens which the author and two of his students, Mr. William Spoor and Mr. Wilbert Chapman, collected at Cape Arago, Oregon, March 29, 1930.

8. *Bothragonus swanii* (Steindachner)

This remarkable little agonid was found on the exposed southwestern shore of San Juan Island during the summer of 1930. Five specimens were taken from one very low tidal pool on July 26, one on July 27, another two weeks before, and two others from the tidal pool in which our specimens of *Scytalina cerdale* occurred. *Bothragonus* hides under loose boulders, covered by rich growths of algae, and various other plant and animal life. These individuals were variously colored, no two specimens being alike in this respect. One was a rich brown with wide black vertical stripes on its body and a light gray area over the occiput. One specimen was a beautiful bright scarlet, marked with brownish vertical stripes, another was orange and bluish in color. These color markings correspond with their immediate surroundings. Professor Trevor Kincaid has mentioned the finding of two or three of these peculiar fish around the San Juan Islands prior to 1916.

9. *Anarrhichthys ocellatus* Ayres

The wolf fish is a common inhabitant among the rocky islands of Puget Sound and the outer coast. From five to ten specimens are caught by local fishermen in their salmon traps and trawls and are sent to the Department of Fisheries each year. It is no doubt a very common species, for occasionally it may be observed in the fish markets, where it is sold as fillet.

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[6] Edwin C. Starks, Results of an ichthyological survey about the San Juan Islands, Washington. Ann. Carn. Mus., 7 (2), 1911: 185.

10. *Lyconectes aleutensis* Gilbert

This blenny is taken frequently when dredging in soft mud at a depth of 30 or more fathoms. In the Collection of Fishes at the University of Washington, there are a few specimens taken near Olga, on Orcas Island, one of the San Juan Islands in Puget Sound. It prefers without doubt the muddy bottom and lives partly buried, for a bottom sampler occasionally brings to the surface one of these fish. Two were taken in one such haul during the summer of 1930 at Olga. Although but few specimens of this fish have been recorded in the literature, probably it is not as rare as Starks[6] supposed. The lack of specimens indicates a lack of study and thorough collecting rather than rarity.

11. *Scytalina cerdale* Jordan and Gilbert

This most interesting snake-like blenny was observed swimming in a small tidal pool at the base of a steep bluff, on the southwestern shore of San Juan Island, from which three specimens were secured. Two weeks later, during the next series of low tides, ample equipment was brought to this pool in order to excavate the loose gravel and stone. With the aid of Mr. Dunlop of the International Fisheries Commission, Seattle, and Professor George A. Moore of Oklahoma, 29 specimens were taken. The occurrence of this unusual blenny is a new record for the San Juan Islands and Puget Sound, although Starks captured it at Cape Flattery more than 30 years ago.

12. *Microstomus pacificus* (Lockington)

One specimen of the slippery sole was taken at a depth of 135 fathoms in San Juan Channel by dredge, on August 15, 1930.

13. *Ptilichthys goodei* Bean

The quill fish was recorded by the author in COPEIA[7] as occurring in Puget Sound off San Juan Island. An attempt was made in this note to summarize the localities from which *P. goodei* had been taken, but a valuable reference was overlooked, that of Evermann and Goldsborough.[8]

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[7] New Records of the Quill Fish, Ptilichthys goodei Bean. COPEIA, No. 171, 1929: 40-41.
[8] B. W. Evermann and E. L. Goldsborough, The fishes of Alaska. Bull. U. S. Bur. Fish., 26, 1906 (1907): 219-360.

Notes on Philippine Sharks, III[1]
The Hammer-head Sharks, Sphyrnidae

By Albert W. Herre

THE hammer-head sharks present one of the most extraordinary modifications of form known among fishes, a puzzle defying explanation. The sides of the head are produced so that it is more or less hammer or kidney-shaped, and the eyes are placed at the extreme outer edge of each extension of the head.

Some of these sharks attain a large size and are ravenous creatures greatly feared in some regions. I have seen none more than 4 meters in length, but they attain a much greater size. To see a hammer-head shark 3 or 4 meters long, with its strange and extraordinarily expanded head a meter and a half or more in width, is enough to give any one a thrill. The young are caught in numbers in many localities and are common in the markets in the Philippines, Dutch East Indies and the coasts of Hindustan.

The species are few in number; Garman recognized six. At least three of them occur in all tropical and temperate seas.

The family Sphyrnidae is separated from the Galeidae by the strange shape of the head, but is otherwise scarcely different. There is but one genus.

Genus Sphyrna Rafinesque

Sphyrna Rafinesque, Ind. Ittiol. Sicil., 1810: 46, 60; Sicily.

The skull is laterally expanded across the frontal region; the forward portion of the head is broad and flattened, and its sides prolonged outwardly, with the nostrils along its front margin and the eyes on its outward extremities. There are no spiracles; the nostrils are separate from the mouth and from each other, and the eyes have a nictitating membrane. The mouth is crescentic; the teeth similar in both jaws, compressed, oblique, triangular, and notched on the outer edges; the labial folds are rudimentary; the first dorsal is spineless, and over the space between the pectorals and ventrals; there are pits at the caudal origin and the subcaudal lobe is elongated.

KEY TO THE PHILIPPINE SPECIES OF SPHYRNA

A.—Hammer very long and narrow; each lobe 2.5 to 3 times as long as wide ..... *S. blochii*

AA.—Hammer lobes much shorter, never much longer than the width of the lateral margin.

B.—The length of the posterior margin of each lobe about equals width of lateral margin..... *S. zygaena*

BB.—The posterior lobar margin is less than the width near the eye.. *S. tudes*

[1] Parts 1 and 2 appeared in the Philippine Journal of Science, 23 (1), July, 1923, and 26 (1), January, 1925. Another part will appear in a later number of COPEIA.

1. *Sphyrna blochii* Cuvier

Zygaena blochii Cuvier, Regne Animal, 2, 1817: 127. Valenciennes, Mem. Mus. Hist. Nat., 9, 1822: 227, pl. 11, fig. 2. Day, Fishes India, (1878-88): 719, pl. 184, fig. 4.
Sphyrna blochii Müller and Henle, Plagiost., 1841: 54, 199. Bleeker, Verh. Bat. Gen., 24, 1852: 41, pl. 3, fig. 7.
Cestracion blochii Garman, Plagiost., Mem. Mus. Comp. Zool., 36, 1913: 156.

This hammer-head shark is recognized at a glance by the great expansion of the very long narrow lobes of the head, which stand out at right angles to the body. The total width of the head is 1.55 times in the length of head and trunk together, and the breadth of each lobe is contained 2.8 to 3 times in its own length, measured from the side of the head.

The depth enters 5.3 to 5.4 times, the head 3.2 to 3.25 times, the caudal 1.85 to 2 times in the length. The eyes are contained 16 to 16.5 times in the head and are near the upper angle of the outer edge of the elongated lobes; there is a deep groove along the anterior margin of each lobe, extending nearly to the eye; the snout is broadly rounded between the nostrils, which are much nearer the mouth than the eyes; the width of the mouth is more than the distance to the snout and about equal to the distance to the nostrils; the width of the arched mouth is 1.4 to 1.5 times its length. The oblique teeth are deeply notched on the outer edge, in $\frac{30-31}{29}$ rows; the median teeth above are small, more erect, and notched on both edges. The gill slits are about twice the width of the eye, varying from 1.9 to 2.2 times the eye.

The first dorsal origin is above or slightly behind the pectoral base and extends nearly to a vertical from the ventrals. The origin of the second dorsal is above the middle or posterior half of the anal, and is much smaller than the anal, its base 1.5 to 1.66 times in the anal base. The pectoral is of medium size, its base 2 to 2.15 times in its width and 2.5 to 2.6 times in its length. The first and second dorsals, anal, and pectoral are all concave on the posterior margin, and the second dorsal and anal each have an elongated posterior lower lobe; the subcaudal has an elongate lobe.

The color in alcohol is bluish gray, the lobes of the head darker gray above, the head and trunk pale grayish yellow beneath. The pectorals, ventrals, anal, and subcaudal lobe are dusky violet, the dorsals and lower margin of the caudal more or less dusky.

I have two specimens, 410 and 535 mm. in length, from the Turtle Islands in the Sulu Sea, off the entrance to Sandakan Harbor, British North Borneo. (These islands are a part of the Philippines, but through an arrangement with the United States government, are administered by the authorities at Sandakan.)

I have seen many specimens from a third of a meter to more than a meter in length. This very strongly marked species occurs in Philippine waters along the coast of Borneo from Balabac to the Sibutu Islands, and is common in the markets of that region, as well as in Java and the Malay Peninsula. Its recorded range is from the coasts of India to Borneo and Celebes.

2. *Sphyrna zygaena* (Linnæus)

Squalus zygaena Linnaeus, Syst. Nat., 10th ed., 1758: 234.

Sphyrna zygaena Rafinesque, Ind. Ittiol. Sicil., 1810: 46. Jordan and Evermann, Fishes N. and M. Amer., Bull. 47, U. S. Nat. Mus., pt. 1, 1896: 45.

Cestracion zygaena Garman, Plagiost., Mem. Mus. Comp. Zool., 36, 1913: 157, pl. 1, figs. 1-3. Radcliffe, Bull. U. S. Bur. Fish., 34, 1914 (1916): 263, fig. 17.

Zygaena malleus Valenciennes, Mem. Mus. Hist. Nat., 9, 1822: 223, pl. 11, fig. 1. Schlegel, Fauna Japonica, 1847: 306, pl. 138. Günther, Cat. Fishes Brit. Mus., 8, 1870: 381. Day, Fishes India, 1878: 719, pl. 186, fig. 4.

The head is contained 4.5 to 4.8, its width 3.5 to 3.7 times, the depth 7 to 8 times, the caudal 3 to 3.2 times in the length; the head and trunk together are a little shorter than the tail. The body is rather slender and compressed.

The front margin of the head is a broad compound curve with a marked shallow depression at the tip and shallower curves midway on each side; the posterior margin of the hammer approximately equals the lateral margin; a groove extends from each nostril along the front margin of the head half way or more toward the middle of the snout; the small eye equals the length of the first and last gill slits and equals its distance from the nostril; the mouth is far back, its length three-fourths its width. The teeth vary in shape from triangular in front to pavement-like near the angles of the mouth, in $\frac{31-32}{31-33}$ rows in my specimens, the median rows smaller than the others except the most posterior. The origin of the large first dorsal is above or immediately behind the pectoral axil; the length of its base is two-thirds its height and 2.75 to 3.3 times in the distance to the snout tip and 2.15 to 2.4 times in the distance between the first and second dorsal; the posterior margin is more or less concave, and its pointed posterior angle does not reach the vertical from ventral. The origin of the second dorsal is over the anterior third of the slightly larger anal; its pointed tip extends nearly to the caudal. The posterior margin of the anal is deeply concave; its elongate posterior lobe does not extend as far back as that of the second dorsal. The subcaudal lobe is large, its anterior margin 2.5 to 2.8 times in the caudal.

The color varies from slaty gray to reddish or ashy brown above, lighter on the sides and shading into white beneath. The fins are like the body; with dusky margins; the tips of the dorsal and caudal lobes usually with blackish spots which disappear in alcohol.

This description is based on four specimens 450 to 780 mm. in length, from Manila, Palawan and Mindanao. I have also examined a great many other specimens from numerous localities, particularly Cebu, Jolo, Sitankai, Dumaguete and Davao. This species is common throughout the Philippines. Small specimens may be seen on sale in the fish markets everywhere during most of the year. The largest Philippine specimens known to me are between 3 and 4 meters in length, with a head a meter and a third wide. In other parts of the world it has been seen at least 5 meters long. It occurs in all warm seas, north to Japan, California, Massachusetts and the Atlantic coast of France.

3. *Sphyrna tudes* Valenciennes

Zygaena tudes Valenciennes, Mem. Mus. Hist. Nat., 9, 1822: 225, pl. 12, fig. 1. Günther, Cat. Fishes Brit. Mus., 8, 1870: 382.

Sphyrna tudes Müller and Henle, Plagiost., 1841: 53.

Cestracion tudes Garman, Plagiost., Mem. Mus. Comp. Zool., 36, 1913: 159.

The head is contained 3, its width 3.16, the caudal 2.4 times in the length; the snout 2.8, the eye 15.8, times in the head. The hammer is smaller and more nearly transverse than in *S. zygaena;* its posterior margins are at right angles to the axis of the fish; the length of a single hammer lobe is 3.75 times in the head and about 1.2 times in its own width; the posterior margin is nearly straight; the eye is just below the junction of the lateral and front margins and about its own diameter from the nostril. Near the middle of the snout is the short nostril groove, followed by a line of pores. The length of the mouth is half its width. The teeth are in 30 rows above, 29 below; their bases are two-rooted; the median teeth are smaller, those above oblique with a notch on the outer side, those below more erect and narrower, especially near the middle of the mouth.

The first dorsal origin is over the rear margin of the inner side of the pectoral; its height equal to the pectoral length. The small second dorsal is above the posterior half of the anal. The ventrals are before the middle of the length. The anal is elongate; its lower angle produced, its hind margin concave, its base 1.5 times in its distance from the caudal.

The color in alcohol is gray or grayish brown; the top of the head and the fins darker, the under parts paler. In life, or on fresh specimens the first dorsal, and the tips of the second dorsal and lower caudal lobe are more or less black.

Described here from a specimen 475 mm. long.

This species occurs infrequently in the markets in various parts of the Islands. I have collected it from Manila Bay, Cebu and Zamboanga. It attains a large size but I have seen only the young, none of them more than a meter long. It lives in all tropical and warm-temperate seas.

Natural History Museum, Stanford University, California.

Ichthyomyzon concolor in the Coosa River at Rome, Georgia, with Notes on Other Lampreys in our South Atlantic and Gulf Drainages

By E. W. Gudger

On April 25, 1930, I received a letter from Capt. C. F. O'Keefe, U. S. A., in charge of locks and dams on the Coosa River at Rome, Georgia. He wrote that he was sending some "parasite sucking fish," and when the package came and was opened it was found to contain 7 specimens of the silver lamprey, *Ichthyomyzon concolor* (Kirtland). Of these specimens Capt. O'Keefe wrote that:

> The "Suckers" were from both large mouth bass and from channel catfish caught recently in the Coosa River here. One of the catfish had five (5) suckers attached. The suckers usually fall off when the fish are landed. I have caught several bass this season with spots on them indicating that they had gotten rid of the suckers.

DATA ON ICHTHYOMYZON FROM ROME, GEORGIA

Number	1	2	3	4	5	6	7
Length in mm.	130	138	147	169	172	180	199
and inches	5.1	5.4	5.8	6.7	6.9	7.1	7.9
Teeth on supra-oral lamina	2	2	2	2	2	2	2
Teeth on infra-oral lamina	6	7	9	9	8	8	7

These are all small to medium-sized adults, probably about a year old after metamorphosis, in which, however, even in the largest, the eyes appear rudimentary, still covered by the epidermis. The only indication of the pineal body ("eye") is a white spot in the skin just behind the single median nasal aperture. The dorsal fin in every specimen is without a notch. Dorsal, caudal and anal fins are continuous; anal definite only under caudal, thence forward found as a thickened ridge or keel showing no evidence of rays. Anus in every fish with a rudimentary papilla much smaller than that found on breeding males.

The supraoral ("maxillary") tooth plate is bicuspid in every specimen. However, in the crescentic infraoral ("mandibular") lamina are found some interesting variations: the smallest fish has 6 cusps, the next larger and the largest of all have 7 each, numbers 5 and 6 have 8 each, while the median-sized fish (169 mm.) has 9, the largest number. The buccal teeth, entirely normal in their general aspect, are in about 3 rows below the mouth, and 7 to 9 rows on the sides and above; the lateral teeth are 2-cusped, the others single. In specimen No. 7 only is there found the bicuspid lingual tooth, the others, however, all have the tongue with a median depression.

In the matter of the southern distribution of the lampreys in America, the following interesting facts will be set forth. Smith (1907) in writing on the fishes of North Carolina says that he has seen the young of *Petromyzon marinus* 6 or 8 inches long at Avoca in Albemarle Sound and quotes C. S. Brimley that he has found adults of the same species in the Neuse River at Raleigh in April and the young in June. Sea lampreys have been long known in this state for John Lawson in his "A New Voyage to Carolina" (London, 1709) says that they are not uncommon, and that one was given him by an Indian. Furthermore, Dr. Carl L. Hubbs, to whom I wrote for information, tells me that in the collections of the National Museum he has examined specimens from Avoca, from Albemarle Sound, and from Kinston, North Carolina. In addition there is at Alma College, Michigan, *P. marinus* material collected at Raleigh, in the same state, in April, 1902.

The next reference to the occurrence of *Petromyzon marinus* on our south Atlantic coast is the mere statement in Evermann and Kendall (1900) that this lamprey is "Not uncommon in the St. Johns River at Volusia Bar at the head of Lake George (Kendall Coll., 1897)." Earlier, however, than this reference, is the mere listing in 1879 of the sea lamprey from an unknown locality in Florida waters by Goode (1880).

There is no record in the literature of the occurrence of the lamprey in the waters of South Carolina. However, one would expect to find it there since it is found in both North Carolina and Florida. This expectation is confirmed by Hubbs (personal communication) who has seen specimens in the National Museum from Abbeville, Waverley Mills, and from a third but undesignated locality.

For Georgia waters I have nowhere found any lamprey even named. The first, and even now the most exhaustive, ichthyological collecting ever done in the northern waters of Georgia was by David Starr Jordan and C. H. Gilbert in 1876. They actually resided at Rome for a month and carried on constant collecting in the Coosa River there, but Dr. Jordan's list of captures (1877) does not include any lamprey. Incidentally it may be of interest to add just here that this was the first major fish collecting expedition of the dean of American ichthyologists. In none of the faunistic papers which have appeared since the above is there any reference to any lamprey in any Georgia streams. Hence it seems important to put Capt. O'Keefe's captures on record and thus establish the fact that at least one species of lamprey, *Ichthyomyzon concolor,* is found in the waters of this state.

The Coosa is an affluent of the Alabama River, which empties into the Gulf of Mexico through Mobile Bay, and it will be of interest to ascertain whether any lamprey has ever been found before in the Gulf drainage east of the Mississippi River.

The only reference to the occurrence of *Petromyzon marinus* in the Gulf of Mexico drainage is the statement by Regan (1911) that one 270

mm. (10.6 inches) long is in the Field Museum, Chicago, labelled "Muscatine, Iowa." Of this specimen Creaser and Hubbs (1922) say that:

> Regan's record of this species from Muscatine, Iowa, is probably erroneous, although based on specimens of *P. marinus* so labelled by Meek (some of which we have re-examined). It seems more likely that labels were transposed than that *marinus* should have been taken in the Mississippi.

Hubbs in a letter surmises that, since Meek collected and studied lampreys in Cayuga Lake, these specimens (now in bad condition) in all probability came from that locality. This suggestion of transposition of labels will appeal to all who have studied old collections of fishes. Furthermore, neither Meek nor any other student of the fishes of Iowa or of the Mississippi Valley has (so far as I know) ever recorded the lamprey from Iowa or from any stream draining into the Gulf.

In connection with this first record of *Ichthyomyzon concolor* from the Alabama River system, it might be noted that this stream has in general a modified Mississippian fauna—a relationship further confirmed by the present discovery. It will be a matter of interest to learn whether or not this species migrates into the Gulf of Mexico.

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Speculation on the History of the Ostariophysi

By J. T. Nichols

Introductory

FOR several years the writer has been primarily engaged in a systematic study of the fresh-water fishes of China, based on very extensive collections gathered by the American Museum of Natural History's Asiatic expeditions. Carp-like fishes dominate this fauna to such an extent, that in a provisional check-list drawn up in 1928[1], 263 of the 374 species recognized (70%) were carps and loaches (with 1 sucker), and 11% of the remainder were catfishes, so that only 19% belonged to non-ostariophysine groups. Comparison of Chinese carps with the familiar American ones has led to speculation as to the history and distribution of this branch of the Ostariophysi, which correlates with similar consideration of the more tropical catfish and characin branches dating from 1917, when Ludlow Griscom and the writer reported on an extensive collection of African fishes.[2]

Concerning the Suckers, Carps and Loaches

Carps are fundamentally non-predaceous, feeding on small animals or even vegetable matter, and are without teeth in the mouth. To take the place of the missing oral dentition they are provided with well developed, variously specialized teeth on the pharyngeal bones (of the throat). In the carps proper these are few in number and definite in arrangement, differing in number, arrangement, and character in different genera, and to a lesser extent in different species. In the suckers the pharyngeal teeth are more numerous, and in a more or less comb-like series.

Loss of oral dentition would have been a rational adaptive change in the suckers, whereas various of the modern active free-swimming carps could, it seems, make good use of such teeth did they possess them. This is particularly true of certain predaceous forms which have developed in China, probably correlated with the long time protection of that area by a Gobi desert system from invasion by such northern predators as pike and trout. There is for instance the genus *Opsariichthys* with crooked interlocking edges to the strong toothless jaws. Several genera with similarly modified jaws occur in tropical Asia. It is then a reasonable assumption, and one generally held, that the suckers are more primitive than and more or less ancestral to the true carps.

The suckers are now North American, except that one northern species (*Catostomus catostomus*) also occurs in Siberia, and that there is a spe-

[1] Nichols, Bull. Amer. Mus. Nat. Hist., 58, 1928: 1-62.
[2] Nichols and Griscom, Bull. Am. Mus. Nat. Hist., 37, 1917: 653-756.

cialized sucker (*Myxocyprinus*) in the valleys of China. This interesting fish was formerly united generically with similar forms of the Mississippi Valley. But as the theoretical probability of any such specialized cyprinoid having crossed between Asia and America is small, the present day view that the resemblance here is a parallelism seems most rational. One may suppose the suckers to have run their course in China, have left but this single peculiar representative behind, and have been superceded more or less by the present-day gudgeons, a division of the true carps, there. In America the group is still relatively young with various genera and many species.[8]

This view would make of China a recent center of differentiation and distribution for carp-like fishes. It probably is this modern center. The true carps are here not only very abundant but more varied than elsewhere, more advanced in evolution or radial differentiation, more deeply cleft. Thus the breams with a single primitive genus in North America, and a couple allied to it in Europe, here make a convenient subfamily with a number of genera some of them rich in species; the gudgeons which seem not to have reached Africa or America and are represented by a few species in Europe make a similar convenient subfamily with unlike genera and many species. *Zacco* and *Opsariichthys* clearly differ generically, whereas the closely allied and somewhat more primitive *Barilius* shows no comparable variation across southern Asia and Africa.

It is obvious that carps have recently entered Africa from the northeast. In that continent they are little varied and form a minor part of the freshwater fish fauna. Few genera are represented, these related to numerous and more varied forms occurring in southern Asia. For instance the genus *Barbus* is represented by a large number of species, particularly in east and south Africa, but these are comparatively undifferentiated, whereas their Asiatic and East Indian allies are separated into numerous well marked subgenera, to which the modern tendency is to give full generic rank. Not so many species have invaded the strong West-African or Congo fauna with its many specialized fishes of older groups.

Carp-like fishes do not enter the neotropical or Australian regions. They are the dominant freshwater fishes of the northern hemisphere. Their present distribution is obviously recent, from the north, from an Asiatic center, apparently China. The differentiation and occurrence of the loaches parallels that of the carps, but is more restricted. Southwestward they have reached Abyssinia. Fragmentary remains of a supposed loach are recorded by Cope from a freshwater Upper Tertiary formation in Idaho, but their identification was probably an error. The group does not occur in America and evidence of its ever having crossed to the New World is inadequate. Because of their many barbels, minute scales, and other characters, it would be excusable to consider loaches archaic with relationship to both carps and catfishes, but they are probably a secondary offshoot of the true carps. Tangible evidence of this is furnished in China by a puzzling fish, *Gobiobotia*, which combines characters of a loach and of a gudgeon.

[8] Nichols, 'Natural History,' 25, 1925: 349.

Concerning Catfishes and Characins

To turn to catfishes and characins, the latter group is confined to the southern continents (South and Middle America, and Africa), and the former is most dominant and diversified in the same areas, though with a general continental distribution. There can be little doubt that both these groups are older than the carps, and whereas tangible evidence bearing on their distribution may be lacking, it is most reasonable to suppose that each invaded their present range from the north where they have since been more or less superceded by the carps.[4] The presence of characins in Middle America is presumably a secondary and recent northward movement of South American forms.

As to which are the older, catfishes or characins, fossil evidence is quite negligible, as it is for this entire group of Ostariophysi, except as it shows them present only in the Tertiary, and much as they are today. Distributional evidence is confusing. Nichols and Griscom, 1917, consider that the distribution of the catfishes was the earlier, basing this opinion on their greater diversification in Africa and South America. From the radial diversity of catfishes there, it would seem that they may well have been the first modern 'Continental' fishes to reach South America. On the other hand, if gymnotids be considered a characin offshoot the development of this peculiar group is evidence to the contrary. Boulenger's opinion that the characins are the most primitive ostariophysine fishes[5] seems sound. Structurally catfishes are more specialized than characins and ancestral Ostariophysi should have been characin-like, pre-characins, even if modern catfishes are older, and their distribution preceded that of the characins of today. In any event some interesting and perhaps significant comparisons may be drawn between the development of these two groups in Africa and South America. There is nothing in Africa to compare with the whole series of South American armoured catfish. In South America there are no other older armoured fishes which might have competed with such a trend; in Africa we have the heavily scaled polypterids. In South America we find the ostariophysine gymnotids which parallel the more primitive and presumably older non-ostariophysine mormyrids of Africa. So catfishes in one direction and characins in another seem to have had their evolutionary potentialities blocked in Africa by older groups which are absent in South America. The ostariophysine potentiality of producing an electric species gives us the electric gymnotid eel in South America, and could there have been gymnotids in Africa there might have been one there also—as it is an African electric catfish has been evolved.

At a superficial glance the systematic ichthyologist sees certain resemblances between catfishes and characins in Africa and in South America, which fade on closer study, and he gets the impression that the evolutionary diversification of both groups in the respective continents has been entirely independent, as it would have been with an invasion of primitive forms from the north prior to such diversification. These fishes

[4] Nichols and Griscom, Bull. Am. Mus. Nat. Hist., 37, 1917: 736-738.
[5] Boulenger, Cambridge Natural History, 1904: 574.

seem to the writer to furnish evidence against any land bridge or other connection between the two continents in Tertiary times.

General Considerations

The fossil evidence on the ostariophysi is too scant to tell us much of their history or distribution, and none of it is pre-Tertiary. The group seems to have been present pretty much throughout the Tertiary, and the opening of that period very likely found it essentially as today with its three main sub-groups already differentiated. The writer's concept of evolutionary dynamics favors the view that it is not in changes correlated with environmental change that significant new adaptations arise, but as evolutionary experiments in one direction or another in a wide, favorable and stable environment where a given form is sufficiently numerous and well established for competition to be keen and of long duration between the individuals which comprise it, not merely between one form and another, or a form and the environment as a whole. A given species quickly expands numerically to its saturation point in a given environment, but by splitting into different species each with some what different habits and adaptations, it may continue to expand. This would seem to be at least one important factor in the origin of species. It is not unreasonable to suppose that between Mesozoic and Cenozoic life there was a long period of stable conditions with few uplifts or depressions, a period of which the fossil record is essentially lacking, a true epi-Mesozoic interval. Such a period would have been characterized by mature drainage systems where a group of fresh-water fishes, the Ostariophysi, might well have been evolved, and the carps arisen as toothless suckers.

The ancestors of the Ostariophysi are unknown and the writer has made no special study to justify speculation as to the relationships of the group to more primitive fishes. It was probably always a freshwater group. Largely on the basis of its membership in modern freshwater fish faunae, these may be separated into *Continental* (Ostariophysi dominant) and *Peripheral* (whose members have marine affinities).[6]

It is interesting to note that the carps, though abundant in the Indies, do not reach the Australian region. Freshwater forms of catfish do occur there, but these are related to the exceptional marine catfish genera, *Plotosus* and *Arius,* hence to be expected.

American Museum of Natural History, New York City.

[6] Nichols, 1928, Amer. Mus. Novitates, No. 319, p. 6-7.

Notes on Fishes, Amphibians and Reptiles of Randolph County, Georgia

By Francis Harper

THE paucity of ichthyological and herpetological records from southwestern Georgia prompts me to offer the following brief notes. They were secured more or less incidentally during the period from March 16 to April 18, 1921, while I was staying on a farm about seven miles northeast of Cuthbert, the county seat of Randolph County.

Nearly all of my observations and collections were made either on this farm or in adjacent territory along a small stream, known as Collins Mill Creek. The country is gently rolling, and it has been largely cleared of timber for the production of cotton, corn, and other crops. Yet a good many patches of woods remain, particularly in the creek bottom. A small mill pond, formed by a dam across the creek, was a favorable collecting ground.

Randolph County lies almost wholly in the 'Southern Red Hills,' a natural division of the Coastal Plain extending 'from eastern South Carolina to northern Mississippi....in a belt about thirty miles wide. The underlying strata are Eocene limestone, marl, chert, shale, etc., but...the prevailing surface material is a reddish loam."[1] The commonest trees in the Georgia portion of the 'Southern Red Hills' are *Pinus taeda, P. palustris, P. echinata, Liquidambar, Quercus falcata, Magnolia virginiana, Liriodendron,* and *Quercus nigra.*[2]

The specimens collected were deposited in the Cornell University Museum. Dr. Sherman C. Bishop kindly made or verified the identifications of the salamanders.

The records of the following species seem to be at or near the southernmost limits of their known ranges in Georgia: *Eurycea bislineata cirrigera, Eurycea gutto-lineata, Bufo fowleri, Hyla crucifer,* and *Natrix sipedon erythrogaster.*

FISHES

1. *Semotilus atromaculatus thoreauianus* Jordan
Southern horned dace

Three with sharp tubercles on snout, taken in Collins Mill Creek, April 1. Locally called 'hornyheads.'

2. *Rabida leptacantha* (Jordan)
Mad tom

One specimen taken in Collins Mill Creek, April 1.

[1] R. M. Harper, Georgia Hist. Quar., 6(2), July, 1922:101.
[2] R. M. Harper, School Sci. and Math., 18 (8), Nov., 1918: 706.

AMPHIBIANS

3. *Plethodon glutinosus* (Green)
Slimy salamander

Eight specimens taken in woods along the creek under logs and planks, April 1. This and other salamanders of the region are called 'ground puppies.'

One of several boys helping me said: 'If one of these ground puppies pops his teeth at you three times you'll die. But I had one pop at me six times.' One or two of them 'popped their teeth' while held in our hands. It was a sort of jaw-snapping act, but 'popping' expresses the slight sound fairly well.

4. *Manculus quadridigitatus quadridigitatus* (Holbrook)
Dwarf salamander

Three specimens, same locality and date as the last.

5. *Eurycea bislineata cirrigera* (Green)
Southern two-lined salamander

One adult collected, March 27, and two larvae, April 1; the former in a clear little 'branch' in the woods.

6. *Eurycea gutto-lineata* (Holbrook)
Holbrook's salamander

One specimen, same locality and date as *Plethodon* and *Manculus*.

7. *Bufo fowleri* Garman
Fowler's toad

One specimen, March 27, among dead leaves in woods near the creek.

8. *Bufo terrestris* Bonnaterre
Southern toad

The following notes doubtless refer to this species rather than to *B. americanus*. In addition to geographical considerations, the powerful, vibrant quality noted in the song of local toads, as compared with the weaker trill of the more northern *americanus*, tends to confirm the provisional identification. Unfortunately I preserved no adult specimens.

Toads were heard trilling on March 18 and 19, April 5, 6, 7, 14, and 15, chiefly after dark, and generally just after rainfall. A rainstorm on March 17, for example, was enough to keep the toads in vocal activity on the 18th and 19th, but not on the 20th and 21st. Again, heavy rain on April 14 set the toads to trilling, when none had been noted during the previous week. On April 5, however, there was vocal activity when the weather had been dry for several days. The temperature during the evening of March 19 was 75° to 72°; on the evening of April 6, 71°; at 6:10 P. M. on March 21 (when no trilling was heard), 78°.

Some of the toads that were in song frequented a mud puddle in the road. On April 5 tadpoles were found in the edge of the mill pond.

9. *Acris gryllus* (LeConte)
Cricket frog

Cricket frogs were heard calling at the mill pond every few days from March 20 to April 6, and several were collected in its marshy edge.

10. *Hyla crucifer* Wied
Spring peeper

This species was heard in chorus on March 16, 17 and 18.

11. *Rana catesbeiana* Shaw
Bullfrog

The powerful notes of the bullfrog were heard at the mill pond on March 20 and 22. The sound readily carried for about three-eighths of a mile.

12. *Rana sphenocephala* Cope
Southern leopard frog

One collected and another seen at the mill pond, April 1.

REPTILES

13. *Anolis carolinensis* Voigt
Green lizard; 'Chameleon'

One collected on April 1; one or two others seen on April 7.

One of the residents said that when this lizard distends its pink throat, they speak of its 'taking out its pocketbook.'

14. *Sceloporus undulatus undulatus* (Latreille)
Pine lizard

Two collected, and others noted rather frequently on fences and in woods. Local names are 'rusty Jenny' and 'rustygut.'

15. *Leiolopisma laterale* (Say)
Ground lizard

Noted quite commonly on the ground among dead leaves in oak and pine woods, March 20 to April 3. One collected.

16. *Eumeces fasciatus* (Linné)
Blue-tailed skink

One collected in woods along the creek, April 1.

17. *Diadophis punctatus punctatus* (Linné)
Ring-necked snake

One collected, April 17.

18. *Heterodon contortrix* (Linné)
Spreading adder

One taken by a farm hand beneath a plow, April 5.

19. *Coluber constrictor constrictor* Linné
Black snake

One collected in pine woods, March 20.

20. *Natrix sipedon erythrogaster* (Forster)
Copperbelly

One taken near the edge of the mill pond, April 5.

At the same place two other water snakes of a mottled color were seen; there were probably *Natrix fasciata fasciata.*

SWARTHMORE, PENNSYLVANIA.

Hynobius tagoi Dunn not a Valid Species

By JUNJI OYAMA

TSUSHIMA Island lies in the Korean Straits along with Iki Island, between Korea and Kyûshû. It measures about 700 sq. km. in area, about 70 km. in length from north to south, 18 km. in its widest extension, and its coast-line is about 700 km. The distance from Korea is 52 km. and from Iki 50 km.

Tsushima has often been wrongly treated as two islands, for it appears as if divided into two parts by an inlet "Asô-wan," which extends from west to east deeply into the land. These two parts thus separated, however, are united by a narrow isthmus, though there exist two canals connecting the waters of east and west coasts of the island. Therefore, each of the two parts is not in itself a complete and independent island, and the whole Tsushima is but a single mass of land that lies in the midst of the Korean Straits. As administrative district, the northern half is called "Kamiagata," and the southern half "Shimoagata."

Fig. 1. A map of Tsushima. a and b, canals; 1, Izuhara; 2, Kuta; 3, Hitakatsu; 4, Izumi; 5, Kawachi; 6, Sasuna; 7, Sago. (1-7, Places where my specimens were collected.)

Such is Tsushima, and from geographical, geological, and as well as from faunal and floral points of view, this island does not belong to Kyûshû proper as Iki does. A mere observation of the fauna of Tsushima reveals a very complicated phase, a mixture of two types, those of Kyûshû and those of Korea. As to *Hynobius,* a urodelan genus, which I am now treating, I found a feature peculiar to this island and entirely different both from those of Kyûshû and Korea.

It has been known that in Tsushima lives a kind of *Hynobius.* In 1907, Stejneger and Tago acknowledged it as *H. nebulosus* (Schlegel), but Abe, in 1922, named it *H. tsuensis,* a new species.

On the other hand, Dunn, in 1923, from an examination of only a single individual obtained from the northern half, considered it as a new species, differing from *tsuensis* chiefly in its color pattern, and named it *H. tagoi.* It is his view that this species is restricted to the northern half of the island, and *H. tsuensis* to the south. For this reason he regards Stejneger's specimen as referable to *tagoi.*

In 1926 Mori adopted Dunn's view. Tago holds insistently his own original view that *tsuensis* is synonymous with *nebulosus,* while acknowledging *H. tagoi* as a distinct species.

Thus it has been thought of late that the north and south parts of Tsushima are inhabited respectively by a distinct species of *Hynobius.* Mori, thinking that *H. tagoi* of northern Tsushima and *H. leechii* Boulenger of Korea have something in common with each other, went so far as to regard *tagoi* as a subspecies of *leechii,* giving it a subspecific name, *H. leechii tagoi.*

In 1927, as a result of observation of some living adults and egg-sacs of *H. tsuensis,* I could confirm that *tsuensis* was valid and was an entirely different species from *nebulosus,* and at the same time the existence of a distinct species *tagoi* appeared to me very doubtful. Thus, holding rather a negative opinion to Dunn and others, I visited Tsushima this spring (1930) and collected numerous adults and egg-sacs of *Hynobius* in both parts of the island. The observation of these materials has confirmed my supposition at once, and swept off all my doubts. The egg-sac of *tsuensis* is quite peculiar in its shape and, moreover, the embryos show their own features of development. All the salamanders in the northern part are nothing but *H. tsuensis,* the species to which the forms of the south belong. According to my observations, *tsuensis* shows many grades in its body-coloration, which has nothing to do with sex difference. Dunn's *tagoi* has been based on an individual of *tsuensis,* the color pattern of *tagoi* is within the range of variation of the latter species, and I may safely conclude that there exists no species that can be distinguished as "*H. tagoi.*"

Thus, so far as I can see at present, the whole island of Tsushima is inhabited by only one species of *Hynobius*: it is *H. tsuensis,* distinct from both *H. nebulosus* and *H. leechii.*

Zoological Laboratory, Kyûshû Imperial University, Fukuoka, Japan.

Ichthyological Notes

NOTE ON THE SCALES OF APOGONID FISHES.—Through the kindness of Dr. Hugh M. Smith, I was permitted several years ago to take scales from the type series of a number of species of *Apogon* (then described under *Amia*) from Philippine waters. I noted at the time that there were some striking diversities, but the matter has remained in abeyance, and may now be briefly discussed.

In two species, *Apogon striatus* (Smith and Radcliffe) and *A. albomarginatus* (Smith and Radcliffe), the circuli in the region just below the ctenoid area, right across the scales are replaced by very fine transverse lines, anastomosing at intervals, and exceedingly dense. On tracing these lines to the circuli at the sides, it is apparent that they are not in reality any part of the circuli themselves, but are modified from minute oblique lines in the intervals between the uppermost (most apicad) circuli.

The scales of these two species are very much alike, but may be distinguished by the fact that in *A. striatus* the circuli reach the lateral margins very obliquely, being directed outward and apicad; whereas in *A. albomarginatus* they are much more transverse.

The dense lines below the ctenoid area are not present in the other species examined, namely *A. fasciatus* (White), from Moreton Bay, Australia, and *A. uninotatus* (Smith and Radcliffe), *A. nigrocinctus* (Smith and Radcliffe), *A. robustus* (Smith and Radcliffe), *A. angustatus* (Smith and Radcliffe) and *A. compressus* (Smith and Radcliffe) from the Philippine region. But in *A. compressus* there are along the sides of the apical region very fine vermiform lines, representing the same structures. In the basal region, between the radii, the circuli are very much more dense in *A. compressus* than in *A. fasciatus*.

Mionorus Krefft was separated from *Apogon* on account of the smooth-edged preopercles. *A. striatus* and *A. albomarginatus* have it partly or mainly smooth; but *A. uninotatus* has it smooth, while the remaining species have it serrate or dentate. Thus the difference in the scales appears to have no bearing on the validity of *Mionorus*.

Cheilodipterus nigrotaeniatus Smith and Radcliffe, has very coarse ctenoid elements in many rows, and no fine transverse lines below. *Apogonichthys pomarae* Steindachner (Society Islands) also lacks the fine transverse lines. *Glossamia aprion* (Richardson) has rounded, transversely oblong scales very unlike any of the above.—T. D. A. COCKERELL, *University of Colorado, Boulder, Colorado.*

SUCKERS EATING TROUT SPAWN AT NIGHT.—During the first week in October I was in the Patapedia Lakes section near the headwaters of the Patapedia River in the Province of Quebec. Next to our camp was a small round bay, perhaps one hundred feet across, with a very narrow outlet into Montagnais Lake. In this bay, which has a number of bubbling springs, were four trout spawning beds in perhaps a foot of water. The water was clear as crystal, and the trout as plainly seen as could possibly be. I frequently would drift over this bay in a canoe, and never saw a sucker on these spawning beds during the day. In the shallow gravel bar at the mouth of the bay, and along the edge of the lake at each side, suckers could be seen in great abundance. About eight o'clock one dark night, I drifted over these spawning beds in the little bay, and used a strong flashlight to illuminate the water. The bottom was plainly visible in the limited area within the light's rays. For the first time I saw suckers on the spawning beds, and when they were revealed by the flashlight they were immediately chased off by the trout. The trout, however, seemed undisturbed and indifferent to the light. I then went to the mouth of the bay and along the shore of the lake, and the light revealed suckers in this area, but when the light was played upon them they hastened away.

From the foregoing, it is not unreasonable to conclude that suckers prey on trout spawning beds largely at night by reason of the fact that then their raids are more apt to escape the trout's notice.

I am sorry that I did not have an opportunity to observe what the circumstances might be in the case of a clear bright moonlight night. FRANCIS K. BARBOUR, *200 Hudson Street, New York City.*

Herpetological Notes

A NOTE ON THE DISCOVERY OF THE GENUS *TYPHLOPS* IN THE HAWAIIAN ISLANDS.—A harmless and widely distributed little worm-snake of the genus *Typhlops* has lately been discovered in the Hawaiian Islands. Through the courtesy of Mr. D. T. Fullaway, Entomologist for the Territory of Hawaii, the writer has had the privilege of examining one of the two specimens taken and it is with the permission of Mr. Fullaway that the record is published. Unfortunately one of the snakes was accidentally destroyed but the remaining one, now in the collections of the Territorial Board of Agriculture and Forestry, has been identified by the writer as *Typhlops braminus.* The credit for the discovery of this little worm-snake is due Mr. Paul Gantt, who in January, 1930, found the two specimens mentioned on a soil heap taken from an excavation for a power pole near the Bishop Museum in Honolulu. —JOSEPH R. SLEVIN, *California Academy of Sciences, San Francisco, California.*

NOTES ON AN *ARIZONA ELEGANS OCCIDENTALIS* BLANCHARD. —On the twenty-third of February, 1930, the writer took a short collecting trip to the ocean beach near International Boundary Monument Number 258. The sandy beach is practically level for several yards from the water's edge before a mesa rises to a higher level. The sand is strewn with boards and debris, and ice plant grows here abundantly. In the debris several species of lizards were found at various times, namely: *Sceloporus occidentalis biseriatus, Uta stansburiana hesperis, Anniella pulchra, Gerrhonotus scincicauda webbii* and *Eumeces skiltonianus.* Soon after sunset, when preparing to leave for home, a plank was overturned revealing an *Arizona elegans occidentalis* or western faded snake, nearly 12 inches long. It was nosing its way through the sand and did not seem disturbed by my presence. It was immediately placed in a sack with several lizards *(Uta stansburiana hesperis),* since I had no empty sacks.

When homeward bound the sack containing the snake showed considerable activity but because of the nocturnal habits of this snake it did not seem surprising. On arriving at my destination the beautiful little snake was admired and handled gently. In the course of a few minutes two lizards were disgorged, one had been swallowed head first, the other tail first. It is odd that under such abnormal conditions lizards should be taken voluntarily. Mice are common in this area, so lizards and mice must be on the food list of this snake in nature. White mice were taken voluntarily in captivity.—LORENZO H. COOK, *San Diego Natural History Museum, San Diego, Calif.*

REVIEWS AND COMMENTS

MANUAL OF THE VERTEBRATE ANIMALS OF THE NORTHEASTERN UNITED STATES INCLUSIVE OF MARINE SPECIES. 13th Edition. *By David Starr Jordan.* World Book Company, Yonker's-on-Hudson, New York, 1929, xxxi+446 pp. $4.00—The influence which this work has had on the naturalists of America is indicated by the tributes given it in this number of COPEIA by Evermann and by Fowler. To perhaps no other one work can we attribute as powerful a role in the development of natural history in America as to the "Manual" of David Starr Jordan. Many indeed are the biologists of America "brought up on the Manual of the Vertebrates."

The most recent edition of the long line through which the "Manual" has passed is thoroughly up-to-date. In its preparation, Doctor Jordan obtained the services of specialists: the reviewer for fishes; Dunn for amphibians; Ruthven for reptiles; Oberholser for birds, and Jackson for mammals. But through it all we still see the imprint of the master naturalist, whose interests were so much wider than those of us younger naturalists. Will the future produce such naturalists as David Starr Jordan?

The Manual of Jordan no longer stands alone, but it still remains supreme in its field, beyond comparison better than any like work. No naturalist, from the most advanced specialist to the beginner of high school age, should be without the thirteenth edition of David Starr Jordan's Manual of the Vertebrate Animals.—CARL L. HUBBS, *University of Michigan, Ann Arbor, Michigan.*

PUBLICATIONS OF THE UNIVERSITY OF OKLAHOMA BIOLOGICAL SURVEY. VOL. I. No. 1. Tentative program of the University of Oklahoma Biological Survey. *By A. Richards.* No. 2. Further notes on the fishes of Oklahoma with descriptions of new species of Cyprinidæ. *By C. L. Hubbs and A. I. Ortenburger.* No. 3. Fishes collected in Oklahoma and Arkansas in 1927. *By C. L. Hubbs and A. I. Ortenburger.* Norman, Okla., April, 1929.

In the twenty years following the publication of Jordan and Evermann's monumental "Fishes of North and Middle America," 1896-1900, little of any great importance was contributed to our knowledge of the taxonomy and relationships of the freshwater fishes east of the Rocky Mountains. Indeed many considered that in most cases the final word had been said and little or no deviation from the system of Jordan and Evermann is to be observed in the papers of this period. A few, however, realized that the work was not completed, and now, after thirty years, those few have had their suspicions vindicated. The flood of light which has been let into the maze of taxonomic confusion among our North American cyprinids, catostomids, cyprinodonts, and darters by the recent researches of Dr. Hubbs makes it plain to those who have carefully studied the results that the end is yet far.

The two papers reviewed form part of these researches, being the ichthyological results of the Oklahoma survey carried on by Dr. Ortenburger in 1926 and 1927. The field work was done by Ortenburger and most of the taxonomic investigations by Hubbs. The first paper deals with the collection obtained from the Red River and Arkansas Basins in Oklahoma in 1926 and the second with the fishes taken in Eastern Oklahoma and Western Arkansas in 1927.

The additions to distributional data are many and the taxonomic results of considerable interest. The discussion of the 4-barbelled cyprinoid *Extrarius*, the extension of its limits, the variations and development of the barbels, and their adaptation, clears up much in regard to this genus. Of particular importance is the rediscovery and systematic placement of the remarkable *Cochlognathus ornatus* of Baird and Girard. The sharp and exposed jaws are found to be a seasonal sex character of the male and the types are specifically identical with those of *Ceratichthys vigilax*, a prior name. The species usually known as *C. vigilax* becomes *Hypargyrus velox*. Besides these

and many notes on the taxonomy of other groups and on hybrid centrarchids, the discovery at the present time of four new North American Cyprinoids in a restricted region is in itself a notable event.

The fishes of Oklahoma have not been well known, and these two papers, although only a contribution to the ichthyology of the state, form extremely valuable additions to our knowledge. Their value is not bounded by state lines, and they must be in the hands of everyone who works at the taxonomy of Mississippi Valley fishes.—GEORGE S. MYERS, *Natural History Museum, Stanford University, California.*

REPTILES, AMPHIBIANS AND FISHES. *By C. W. G. Eifrig.* Rand McNally and Company, 1930. viii+249 pp. $1.28.—Written in a clear and pleasant fashion, this attractive little volume, the second in "Our Great Outdoors" series, should provide an excellent introduction to a knowledge of the cold-blooded vertebrates for the child who is interested in natural history. The author has adapted the book for use in the fifth and sixth grades, and its need is proven by the many requests one receives for information about these animals from young students.

The makeup of the book is commendable. There are a number of colored plates, and the many photographic reproductions, mostly of live animals, will add to the young reader's pleasure. The descriptions are simple; when it has been necessary to use scientific terms, these are explained in the glossary. The author's personal observations on these animals add to the interest, and his appeals for their preservation are not unduly sentimental. The directions for the making and maintaining of aquaria and terraria will aid the teacher as well as the student. The errors are minor, mainly caused by too general statements, which are hard to avoid in this type of book, and which may easily be corrected in the next edition.—HELEN T. GAIGE, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

EDITORIAL NOTES AND NEWS

Jordan Anniversary Number

THE Society wishes to express its appreciation to the many members, and other well-wishers of DAVID STARR JORDAN, who by scientific and by financial contributions have made this little tribute possible. Our only regret is that we have been unable to make it at all commensurate with the greatness of our leader. But we have meant well.

Zoological Record

THIS indispensible record of the Zoological literature should be in the hands of every systematist and naturalist. Formerly it was necessary to subscribe for the entire volume, and it is of interest to note that for many years DAVID STARR JORDAN was listed as one of the very few American subscribers. Now it is possible to receive separates of the parts. The Zoological Society of London sells the separates for *Pisces* at 3/6 and for *Amphibia and Reptilia* at 3/0. Separates for most of back numbers of this century are available, as are also many previous whole volumes. Some volumes are almost impossible to obtain, but the Editor knows of an available complete set of excerpts and separates of the *Pisces* part.

Zoologists and zoological institutions receive a valuable service from the Zoological Record, and should reciprocate by sending in publications for listing, by subscribing to the whole volume or to parts and if means allow, by contributing financially to the expensive undertaking.

New York Aquarium

AT the New York Aquarium, construction work is under way on an exhibit of small, freshwater, tropical fishes. There will in all be 72 tanks of varying sizes. Mr. C. M. Breder, Jr., of the Aquarium staff, is at present gathering together suitable material for this exhibit. He is interested in getting in touch with anyone who has unusual forms, or who may be in a position to bring such material into the country.

Personal Notes

PHILIP H. POPE has recovered from a long term of ill health. His friends rejoice in the news. Both Mr. Pope and his wife, also a herpetologist, are teaching in Whitman College, Walla Walla, Washington.

PHILLIPS PUTNAM, a graduate student in Washington State College at Pullman, is completing an investigation of the habits of the singular frog *Ascaphus*.

PROF. A. R. CAHN of the University of Illinois is at work on a monograph of the turtles of that state, and would welcome any records.

MR. JAY A. WEBER, 151 Grand Avenue, Leonia, New Jersey, reports that he has live and preserved herpetological specimens from New Jersey, and that he wishes to arrange exchanges for specimens from other regions.

Recent Deaths

OLIVER PERRY HAY, retired associate of the Carnegie Institution of Washington, died on November 2, in his eighty-fourth year. In his earlier years Dr. Hay published a number of papers on fishes and reptiles, including reports on field work in the southern states, and *The Lampreys and Fishes of Indiana*. He was the first curator of ichthyology and herpetology in theField Museum. Work on the comparative anatomy and development of the vertebral column lead to extensive in-

vestigations into fossil vertebrates, including fishes and reptiles—culminating in his *Catalog and Bibliography of the Fossil Vertebrates of North America.*

Word has been received of the death in July of José Steinbach, the veteran zoological collector of Bolivia, who had so materially contributed to the increase in the knowledge of the reptiles and amphibians of his native land, by making frequent collections and sending them to the herpetologists of this country and Europe.

James S. Hine, Curator of Zoology in the Ohio State Museum, and an enthusiastic member of our Society, died suddenly late in December, at his home in Columbus.

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